THE

INTERNATIONAL

SUGAR JOURNAL

WITH WHICH IS INCORPORATED

THE SUGAR CANE,

(1869-1898,)

A MONTHLY MAGAZINE,

DEVOTED TO THE INTERESTS OF THE SUGAR INDUSTRY GENERALLY

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Blyth Bros. & Co., Mauritius, report shipments of sugar from August 1st to November 14th as 39,435 tons, against 43,221 tons in the corresponding period of 1901-1902.

Exports from British Guiana from January 1st to 1st December:—sugar, 97,764 tons; rum, 2,813,323 gals.; molasses, 1316 casks; cocoa, 99,693 lbs.; against 73,128 tons; 2,241,358 gals.; 1112 casks; 88,348 lbs. respectively for the like period last year.

The Beginning of the End.

The Volume of *The Sugar Cane*, for 1872—thirty years ago—describes the beginning of the struggle for free trade in sugar,—we hope this Volume of 1903 will give the end of it.

To prove that there were bounties; that they were contrary to free trade and injurious not only to our home and colonial industries but also to the interest of the consumer, was the first task. Then came the question of the remedy; the long fight for the principle of levying the duty on the finished product as it went to the consumer, as the only method of abolishing the indirect bounties of those days. Negotiations—complicated, technical and interminable—are fully described in our columns during the years 1874-1877; and then sprang up the great central difficulty, how to give to the contracting parties security that when they had abolished their bounties they should not be liable to contend against bounties given in other quarters or by recalcitrant members of their own combination. This could only be secured by admitting the principle of countervailing

the injurious effects of a bounty and thereby restoring the free and open competition essential to the maintenance of free trade.

"A duty to countervail a bounty is not only consistent with free trade but positively conceived in the interest of free trade." So wrote a good authority some twenty-five years ago, and now our Government have at last accepted the statement and acted upon it. The result has been successful negotiations and a Convention which will probably be ratified by all the contracting parties and will abolish bounties on the first of September.

But we still have to fight against the erroneous views and gross misstatements which find such willing listeners among the careless minds that will not think, and such eager appetite among those who are always ready to swallow sensational falsehoods rather than sober truths.

The worshippers of the fetish they ignorantly mistake for Free Trade—which they call "cheapness"—still fail to see that there is an artificial as well as a natural cheapness. The latter is to be desired, and must not be interfered with. That is true Free Trade. But the worshippers of the false fetish are clamouring for the artificial cheapness, which must inevitably destroy natural sources of supply, and produce artificial dearness. They cry out that the abolition of bounties will bring "dear sugar." In other words, they condemn and reject free and open competition—the very foundation and definition of Free Trade. The price of this "dear sugar" will be governed solely by supply and demand, by the cost of production, and the survival of the fittest. That they reject, and demand in its place an artificial price, sometimes very low and, consequently, sometimes very high, with constant discouragement to natural production, and the ultimate establishment of an artificial monopoly. They boldly declare that this country will lose seven or eight millions a year by the rise in sugar. Rise from what? Under the bounty influence, sugar is sometimes at six shillings per hundredweight, sometimes at sixteen, and occasionally at twenty-six—fluctuations entirely caused by bounties, which first artificially stimulate an over-production, and then, by glutting the market, cause an equally artificial shrinkage in supplies. This our opponents call free trade.

Others snatch at another straw, the most-favoured-nation clause in our commercial treaties, and declare that the Brussels Convention is an infringement of that sacred institution. They fail to see that it is the bounty which infringes the clause, by giving to foreign producers preferential treatment in markets which are bound by treaty to secure equality to all comers. The Brussels Convention abolishes this preference and restores the equality.

These, and minor cavillers, will no doubt do their best to wreck a measure which, as M. Yves Guyot truly says, has done more to

promote the principles of free trade than any since the days of Cobden. Fortunately we have a strong Government and a good majority in the House of Commons on our side; but falsehood must be exposed and error corrected as persistently as ever until we are safely out of the wood.

Sugar in the 18th Century.

In a description of baronial life in Scotland on the eve of 1745, which has been appearing in the *Glasgow Herald*, some mention is made of the items to be found in the larder of a particular mansion at that date. In this connection we read: "During the two years and over about a hundredweight of sugar is used—powdered at 6d., refined at 9d., and loaf at 1s. a pound. As no account is taken of wine possets (save as a sillabub, *i.e.*, wine or cider mixed with cream) or of tea, this must have gone to the sweetening of the dinner table." In the same paragraph appears the sentence: "It is hard to say under what head to put the mysterious 'Holland sand.'" It appears to us that this probably meant brown "Demerara" sugar, perhaps brought from Dutch Guiana. At any rate, it brings to one's mind the at one time too frequent custom, on the part of the grocer, of "sanding" his sugar so as to enhance his profits.

Concerning Natal Sugar.

A not unreasonable complaint has been made in the Natal papers, that whereas Natal sugar has to pay a duty of £3 10s. per ton on entering the Transvaal, Mozambique sugar passes in free. It appears that in accordance with an arrangement made as far back as 1875, all Mozambique produce, except liquors, has passed free in to the Transvaal and *vice versa*: One would have expected that on the establishment of British rule this favouritism would have been denounced, but so far this has not been the case. The Natal Government are blamed for this; an offer was made to them by the Transvaal Government only to be refused. They are said to be muddling affairs, and to have arranged the inter-colonial transit duties so as to benefit one industry alone. Apparently some trouble is looming up for the Natal sugar industry unless there is a change of Government.

Errata.

We have been requested to point out that in the "Note on Large Discrepancy shown between the calculated and found calorimetric value of Bagasse," which appeared in our last issue three errors occurred. Line nine from top: for "7883" read "7833": twentieth line from top for "3·8%" read "3·7%"; and third line from end of note for "bagasse" read "calorimetric."

THE COST OF THE BRUSSELS CONVENTION.

The opponents to the ratification of the Brussels Convention for the Abolition of Sugar Bounties have made so much of late of the assertion that the resulting cost to Great Britain would amount to £8,500,000 per annum, that a clear refutation of this specious statement is really needed. And for this purpose we cannot do better than reproduce two short letters appearing lately in the London press, and dealing with this argument.

To the Editor of "The Westminster Gazette."

Sir,—In your issue of December 2nd you deal with a correspondent who had complained that the probable cost of the Brussels Convention to this country had been overestimated.

Will you allow me to point out that if this estimate is excessive the responsibility rests with Mr. Chamberlain? Speaking in the House of Commons on July 31st, 1902, he said that the disadvantage of the bounty system was at least £5 a ton to the West Indian planter.

It follows that the gain to the British consumer is also £5 a ton, and as we imported last year 1,700,000 tons, this works out to £8,500,000 per annum.

What authority Mr. Chamberlain had for his statement I do not know.

Yours obediently.

Harold Cox, Secretary of the Cobden Club.

6, Raymond Buildings, Gray's Inn, W.C., December 5th, 1902.

To the Editor of "The Westminster Gazette."

Dear Sir,—Under the above heading in your issue of to-day the Secretary of the Cobden Club says that Mr. Chamberlain, speaking in the House of Commons on the West Indian Grant on July 31st, 1902, said that "the *dis*advantage of the bounty system was at least £5 a ton." Quite so, the *dis*advantage, but Mr. Chamberlain did not say that the *ad*vantage to the British consumer was consequently £5 a ton, as, speaking in the House of Commons on November 24th, 1902, he said:

"I come now to a very important point, and that is the argument of honourable gentlemen opposite that the price we are to pay is too high. The right hon. member for West Monmouth told you, and other hon. members also, who, I think, if they had really studied the question would have refrained from such an argument, that the cost to the country will be the amount of the bounty, which they put at the maximum of £5, multiplied by the total importation into this country. That really is perfectly ludicrous. Anybody who knows the true facts of the case knows that, whatever may be the amount of the bounty, the advantage to the consumer is very much less. A large part of the bounty goes to countervail the natural advantages

of the country against which the bounty is directed, and as to the rest, it is divided between the consumer on the one part and the producer on the other. He takes as much as he can and *gives to the consumer the least possible amount which is necessary in order to secure the market.*"

Yours obediently,

R. RUTHERFORD.

34, Great Tower Street, E.C., December 6th.

ELECTROLYSIS IN BEET JUICE EPURATION.

Many modes for beet juice epuration by means of electrical currents have been proposed, and in some cases they have been given practical trials; but after the second sugar campaign, they are generally abandoned. Our attention has been directed to a German mode patented some time since that appears to promise a certain future. In this process, basic lead combinations are used. The treatment of saccharine juices by electricity with the view to their epuration does not appear practicable when the acids and alkalies are separated through diaphragms at the same time. The difficulty appears to be in the resistance offered by this filtering medium. If one eliminates only the alkali by electrolysis or by amalgamation at one of the negative electrodes, the current expenditure is of less importance; but by the use of positive electrodes that are not attacked by acids, the acid that is liberated continues to remain in the juice; this difficulty can not be readily obviated by any known mechanical device. One fact is certain, that up to the present time no important beet juice amelioration has been obtained by the use of positive electrodes consisting of soluble metals, such as zinc or lead. The new mode is based upon the separation through electrolysis of the alkalies, and the neutralization of the acid, liberated by their combination, on the positive electrode, consisting of basic oxides of lead or zinc, but mainly of a saccharate of lead simply suspended in the juice. The insoluble non-sugar combinations are separated in their metallic state. It has been noticed that, when the non-sugar lead combinations are mixed with after-products of a sugar factory containing an excess of alkali, there will be certain transformations, resulting in saccharate of lead that may be separated by simple mechanical filtration. A practical example is given by the inventors. They suppose that 0·3% lime is added to a diffusion juice, this subsequently carbonated, then carbonate of lime is added, and the product filtered. The clear juice obtained is mixed with 8 to 10% of its weight of moist saccharate of lead, and is then thoroughly stirred by means of injected air, which is considered the best means of keeping the saccharate of lime in suspension during the operation of electrolysis; furthermore to force the circulation between the two electrodes with a

pump. It is claimed that the best positive electrode consists of natural or artificial carbon; for the negative electrode iron plates are used; and parchment paper as a diaphragm. With about one inch spacing between the electrodes, and 8 to 10 volts tension, the intensity of the current at the start is $1\frac{1}{2}$ amperes per square decimeter.* As the operation progresses, and the alkali is eliminated by electrolysis, the intensity of the current diminishes; as an average for the area under consideration, one ampere appears to be reasonable. The operation is terminated when with a sample of the filtered juice a drop of lead acetate no longer gives a precipitate. The alkaline solution need not be renewed after each operation. In the practical working by this mode, for every cubic meter of juice treated per diem, there is needed $\frac{1}{4}$ square meter of surface for the electrodes (for 264 gallons juice, there is needed 387 sq. inch surface) and 10 H.P. per hour. No invert sugar is formed, and the juice is said to have a purity of 96 (?). To the moist lead combinations of non-sugar, there is added one-fifth of its weight of sugar as an after-product from first and second swing-outs, and two and three times its weight of a normal alkaline solution, diluted to $1\frac{1}{2}$, then mixed and brought to a temperature of about 50° C. It is pointed out that the liquor free of sugar contains non-sugar and lead formed during the electrolysis; this is saturated by carbonic acid. To the residuum, lime is added with the view to regeneration of the alkali. It is claimed that the losses are more than compensated for by the alkali extracted by electrolysis. Whatever may be the advantages of this new mode of purification, we can never recommend a process for practical factory work, depending upon a lead salt in any form, notwithstanding the fact that it may be entirely eliminated in careful laboratory handling. It is sufficient that some phase of the factory manipulation be neglected to considerably endanger public health by innocently introducing the product upon the markets.—(*Sugar Beet.*)

INFLUENCE OF LIGHT ON GOLDEN SYRUP.

By Sigmund Stein,

Manager, Sugar Refinery, Liverpool.

For the last four years I have been studying the problem of how light influences the character of Golden Syrup.

I was led to take observations on this point by noticing the fact that a given syrup did not crystallise in a sample glass which was kept exposed in the sunlight; whereas the same syrup kept in barrels crystallised after a time. I observed the same phenomenon in

* 9·29 sq. decimeter = 1 sq. foot.

different syrups, of which some portions were kept in the dark and others exposed to the light.

I therefore analysed a given syrup prior to its being placed simultaneously in a white glass bottle and in a barrel. After a few weeks the syrups kept in the bottle and in the barrel respectively were tested again, and they showed a slight difference in analysis.

The glass bottle I kept for a length of time, and put syrup from the barrel into a bottle which was covered with black paper. The latter bottle was so treated in order to produce the same conditions as held with the syrup lying in the barrel.

I have used, in the course of my experiments, different kinds of cane sugar syrups. All these were syrups from sugar refineries. When first received, they were all perfectly bright and clear.

Below are published 72 analyses of the six varieties of syrups. There are 36 analyses of these varieties of syrups which have been kept in white glass bottles exposed to the light, and 36 analyses of the same syrups which have been kept in bottles covered with black paper.

The analyses given below are marked—

A and a	C and c	E and e
B and b	D and d	F and f,

each corresponding, and which show always the same kind of syrup under two different conditions, *i.e.*, exposed to the light and not exposed, but in a black covered opaque bottle.

As the figures speak best for themselves, I leave the results to be deduced from them.

The analysing was carried out very carefully. The polari-metric reading was done, with the newest apparatus and with the greatest precaution. The dextrose and levulose were determined—polarimetric and gravi-metric. Of every determination three to four analyses have been made, and the average of these has been taken.

I have compared the colours of the different syrups, choosing eight standards of colour, viz.:—

No. 1.—Very light straw colour.	No. 5.—Reddish.
,, 2.—Light ochre.	,, 6.—Dark reddish.
,, 3.—Orange.	,, 7.—Dark red.
,, 4.—Reddish yellow.	,, 8.—Dark brown.

In the analyses, I have indicated the colours by the number of the standard here given.

I have also indicated the degree of brightness, to show if a syrup is bright or cloudy, very cloudy or dull, thus denoting how the brightness has changed during the time of observation.

I also tasted the different syrups, and have indicated in the tables of analysis below the various kinds of taste the syrup had—whether it was of a very good or fair taste; whether it had a distinct taste, or a slight taste, of caramel; whether it had a full taste (as of pure unburned syrup); whether the taste was sticky (*i.e.*, a burning taste); or, lastly, whether the syrup had a sharp taste (*i.e.*, that the syrup was of a salty character).

My observations lasted from the 14th December, 1900, to the 29th March, 1902.

The analysis and investigation in this respect are being continued, my object being not only to observe the influence of light, but to see as well whether the proportions of different kinds of sugars have any influence upon the keeping character of syrups when they are exposed to the light.

The publication of this article has been delayed owing to my having worked parallel in respect of syrups containing different proportions of saccharose, dextrose, levulose, and undeterminable matter. With regard to the latter, no conclusion can be arrived at yet, as the analyses hitherto made have been of so contradictory a character.

Glad as I would have been to have included in this article details dealing with this latter investigation, I cannot do so now for the reason given, and, therefore, confine myself to those experiments that have yielded conclusive results. But should any definite conclusion be arrived at regarding the different proportions of saccharose, dextrose, levulose, and undeterminable matter, I shall publish it at a later date.

As will be noticed from the analyses given, these have been made at intervals of about three months—that period being chosen because it was seen that a shorter one would not have shown any marked difference.

The conclusions I came to are as follows:—

(1.) Cane sugar syrups are inverted by sunlight if exposed to it for a considerable time.

(2.) The lower the density of the syrup the more it is liable to inversion by sunlight.

(3.) The inversion co-efficient is proportional to the acidity of the syrup.

(4.) The inversion co-efficient is in inverse proportion to the amount of organic and inorganic salts contained in the syrup.

(5.) The lighter the colour of the syrup the more it is liable to be inverted by sunlight.

Analysis of Cane Sugar Syrup. (A.)

(Exposed to the light.)

	1900. Dec. 14.	1901. April 12.	1901. July 19.	1901. Oct. 18.	1902. Jan. 17.	1902. Mar. 29.
Reference No. ..	1	2	3	4	5	6
Saccharose	34·90	34·80	34·50	34·40	34·40	34·40
Dextrose and levulose..	35·72	35·80	36·10	36·10	36·20	36·20
Salts	5·81	5·79	5·80	5·78	5·82	5·69
Moisture	15·53	15·42	15·39	15·41	15·35	15·30
Organic matter	8·04	8·19	8·21	8·31	8·23	8·41
	100·00	100·00	100·00	100·00	100·00	100·00
Dry matter	84·47	84·58	84·61	84·59	84·65	84·70
Specific gravity	1·446	1·446	1·447	1·447	1·447	1·448
Colour	4	4	4	4	4	4
Brightness	Bright	Bright	Dull	Very dull	Very cloudy	Very cloudy
Taste	Fairly good	Fairly good	Fairly good	Fairly good	Fairly good	Fairly good
Acidity	0·070	0·070	0·069	0·064	0·063	0·062

Analysis of Cane Sugar Syrup. (a.)

(In black covered bottle.)

Reference No.	7	8	9	10	11	12
Saccharose	34·90	34·70	34·70	34·70	34·60	34·60
Dextrose and levulose..	35·72	35·90	35·90	35·90	35·90	36·00
Salts	5·81	5·64	5·60	5·64	5·74	5·55
Moisture..	15·53	15·46	15·42	15·40	15·40	15·35
Organic matter	8·04	8·30	8·38	8·36	8·36	8·50
	100·00	100·00	100·00	100·00	100·00	100·00
Dry matter	84·47	84·54	84·58	84·60	84·60	84·65
Specific gravity	1·446	1·446	1·447	1·447	1·447	1·447
Colour	5	5	5	5	5	5
Brightness..	Bright	Bright	Cloudy	Cloudy	Very cloudy	Very cloudy
Taste	Good	Good	Good	Good	Good	Good
Acidity	0·070	0·070	0·069	0·069	0·068	0·068

Analysis of Cane Sugar Syrup. (B.)

(Exposed to the light.)

	1900. Dec. 14.	1901. April 12.	1901. July 19.	1901. Oct. 18.	1902. Jan. 17.	1902. Mar. 29.
Reference No. ..	13	14	15	16	17	18
Saccharose..	38·40	38·10	38·00	37·70	37·40	37·30
Dextrose and levulose..	34·03	34·30	34·40	34·60	34·80	35·10
Salts	5·41	5·39	5·42	5·38	5·39	5·40
Moisture	14·59	14·42	14·40	14·41	14·40	14·40
Organic matter..	7·57	7·79	7·78	7·91	8·01	7·80
	100·00	100·00	100·00	100·00	100·00	100·00
Dry matter	85·41	85·58	85·60	85·59	85·60	85·60
Specific gravity	1·453	1·453	1·453	1·453	1·453	1·453
Colour	2	2	2	2	2	2
Brightness	Bright	Bright	Bright	Bright	Cloudy	Cloudy
Taste	Slight taste of caramel	Slight ditto	Slight ditto	Slight ditto	Slight ditto	Slight ditto
Acidity	0·132	0·134	0·135	0·137	0·135	0·137

Analysis of Cane Sugar Syrup. (b.)

(In black covered bottle.)

Reference No. ..	19	20	21	22	23	24
Saccharose	38·40	38·40	38·30	38·30	38·30	38·20
Dextrose and levulose..	34·03	34·00	34·00	33·90	33·90	33·90
Salts	5·41	5·36	5·30	5·40	5·22	5·27
Moisture	14·59	14·50	14·50	14·46	14·38	14·39
Organic matter	7·57	7·74	7·90	7·94	8·20	8·24
	100·00	100·00	100·00	100·00	100·00	100·00
Dry matter	85·41	85·50	85·50	85·54	85·62	85·61
Specific gravity	1·453	1·453	1·453	1·453	1·454	1·454
Colour	2	2	2	2	2	2
Brightness	Bright	Bright	Bright	Cloudy	Cloudy	Cloudy
Taste	Caramel	Caramel	Caramel	Caramel	Caramel	Caramel
Acidity	0·132	0·135	0·135	0·135	0·135	0·135

ANALYSIS OF CANE SUGAR SYRUP. (C.)

(Exposed to the light.)

	1900. Dec. 14.	1901. April 12.	1901. July 19.	1901. Oct. 18.	1902. Jan. 17.	1902. Mar. 29.
Reference No. ..	25	26	27	28	29	30
Saccharose	36·10	35·90	35·80	35·50	34·90	34·80
Dextrose and levulose..	35·70	35·90	36·00	36·20	36·80	36·90
Salts	4·26	4·26	4·27	4·26	4·26	4·26
Moisture	13·76	13·72	13·75	13·74	13·72	13·70
Organic matter	10·18	10·22	10·18	10·30	10·32	10·34
	100·00	100·00	100·00	100·00	100·00	100·00
Dry matter	86·24	86·28	86·25	86·26	86·28	86·30
Specific gravity	1·458	1·458	1·458	1·458	1·458	1·459
Colour	1	1	1	1	1	1
Brightness..	Bright	Bright	Cloudy	Cloudy	Cloudy	Cloudy
Taste	Full	Full	Full	Full	Full	Full
Acidity	0·056	0·079	0·076	0·076	0·074	0·079

(In black covered bottle.)

ANALYSIS OF CANE SUGAR SYRUP. (c.)

Reference No. ..	31	32	33	34	35	36
Saccharose..	36·10	36·00	36·00	36·00	35·90	35·90
Dextrose and levulose..	35·70	35·80	35·80	35·80	35·90	35·80
Salts	4·26	4·24	4·28	4·30	4·27	4·29
Moisture..	13·76	13·70	13·65	13·68	13·65	13·65
Organic matter	10·18	10·26	10·27	10·22	10·28	10·36
	100·00	100·00	100·00	100·00	100·00	100·00
Dry matter	86·24	86·30	86·35	86·32	86·35	86·35
Specific gravity	1·458	1·459	1·459	1·459	1·459	1·459
Colour	1	1	1	1	1	1
Brightness	Bright	Bright	Bright	Cloudy	Cloudy	Cloudy
Taste	Full	Full	Full	Full	Full	Full
Acidity	0·056	0·079	0·081	0·080	0·086	0·086

Analysis of Cane Sugar Syrup. (D.)

(Exposed to the light.)

	1900. Dec. 14.	1901. April 12.	1901. July 19.	1901. Oct. 18.	1902. Jan. 17.	1902. Mar. 29.
Reference No. ..	37	38	39	40	41	42
Saccharose..	36·50	36·50	36·35	36·30	36·10	36·00
Dextrose and levulose..	35·94	35·92	36·00	36·00	36·20	36·30
Salts	5·16	5·21	5·18	5·12	5·17	5·19
Moisture	14·88	14·82	14·81	14·70	14·75	14·80
Organic matter	7·52	7·55	7·66	7·88	7·78	7·71
	100·00	100·00	100·00	100·00	100·00	100·00
Dry matter	85·12	85·18	85·19	85·30	85·25	85·20
Specific gravity	1·450	1·450	1·450	1·452	1·451	1·451
Colour	6	6	6	6	6	6
Brightness	Bright	Bright	Bright	Bright	Cloudy	Cloudy
Taste	Taste of caramel	Taste of caramel	Taste of caramel	Taste of caramel	Taste of caramel	Taste of caramel
Acidity	0·102	0·100	0·102	0·102	0·106	0·108

Analysis of Cane Sugar Syrup. (d.)

(In black covered bottle.)

Reference No. ..	43	44	45	46	47	48
Saccharose..	36·50	36·50	36·50	36·50	36·40	36·40
Dextrose and levulose..	35·94	35·90	35·90	35·90	35·90	36·00
Salts	5·16	5·18	5·09	5·14	5·18	5·20
Moisture	14·88	14·82	14·80	14·80	14·65	14·60
Organic matter	7·52	7·60	7·71	7·66	7·87	7·80
	100·00	100·00	100·00	100·00	100·00	100·00
Dry matter	85·12	85·18	85·20	85·20	85·35	85·40
Specific gravity	1·450	1·451	1·451	1·451	1·452	1·453
Colour	6	6	6	6	6	6
Brightness	Bright	Bright	Dull	Dull	Cloudy	Very cloudy
Taste	Caramel	Caramel	Caramel	Caramel	Caramel	Caramel
Acidity	0·102	0·100	0·106	0·109	0·109	0 110

ANALYSIS OF CANE SUGAR SYRUP. (E.)

(Exposed to the light.)

	1900. Dec. 14.	1901. April 12.	1901. July 19.	1901. Oct. 18.	1902. Jan. 17.	1902. Mar. 29.
Reference No. ..	49	50	51	52	53	54
Saccharose..	36·85	36·70	36·50	36·30	36·20	36·00
Dextrose and levulose..	36·93	37·00	37·20	37·30	37·30	37·50
Salts	5·92	5·98	5·90	5·94	5·88	5·86
Moisture	16·89	16·75	16·82	16·84	16·79	16·82
Organic matter	3·41	3·57	3·58	3·62	3·83	3·82
	100·00	100·00	100·00	100·00	100·00	100·00
Dry matter	83·11	83·25	83·18	83·16	83·21	83·18
Specific gravity	1·437	1·438	1·438	1·437	1·438	1·438
Colour	4	4	4	4	4	4
Brightness	Bright	Bright	Bright	Bright	Bright	Bright
Taste..	Full	Full	Full	Full	Full	Full
Acidity	0·109	0·110	0·110	0·112	0·114	0·117

ANALYSIS OF CANE SUGAR SYRUP. (e.)

(In black covered bottle.)

Reference No. ..	55	56	57	58	59	60
Saccharose..	36·85	36·80	36·80	36·70	36·70	36·40
Dextrose and levulose..	36·93	36·95	36·90	36·90	37·00	37·10
Salts	5·92	6·00	5·70	5·86	5·80	5·84
Moisture	16·89	16·84	16·84	16·71	16·70	16·60
Organic matter	3·41	3·41	3·76	3·83	3·80	4·06
	100·00	100·00	100·00	100·00	100·00	100·00
Dry matter	83·11	83·16	83·16	83·29	83·30	83·40
Specific gravity	1·437	1·438	1·438	1·438	1·438	1·438
Colour	4	4	4	4	4	4
Brightness	Bright	Cloudy	Cloudy	Dull	Cloudy	Cloudy
Taste	Full	Full	Full	Full	Full	Sticky
Acidity	0·109	0·111	0·112	0·113	0·114	0·118

Analysis of Cane Sugar Syrup. (F.)

(Exposed to the light.)

	1900. Dec. 14.	1901. April 12.	1901. July 19.	1901. Oct. 18.	1902. Jan. 17.	1902. Mar. 29.
Reference No. ..	61	62	63	64	65	66
Saccharose	37·50	37·40	37·10	36·80	36·50	36·30
Dextrose and levulose..	34·19	34·20	34·40	34·70	34·90	35·00
Salts	4·87	4·85	4·82	4·90	4·86	4·84
Moisture	12·59	12·44	12·49	12·46	12·50	12·41
Organic matter	10·85	11·11	11·19	11·14	11·24	11·45
	100·00	100·00	100·00	100·00	100·00	100 00
Dry matter	87·41	87·56	87·51	87·54	87·50	87·49
Specific gravity	1·466	1·468	1·467	1·467	1·467	1·467
Colour	3	3	3	3	3	3
Brightness	Bright	Bright	Cloudy	Cloudy	Cloudy	Cloudy
Taste..	Sharp sweet	Sharp sweet	Sharp sweet	Sharp sweet	Sharp sweet	Sharp sweet
Acidity..	0·072	0·074	0·082	0·083	0·083	0·089

Analysis of Cane Sugar Syrup. (f.)

(In black covered bottle.)

Reference No. ..	67	68	69	70	71	72
Saccharose	37·50	37·40	37·40	37·20	37·20	37·00
Dextrose and levulose..	34·19	34·20	34·20	34·20	34·30	34·60
Salts	4·87	4·82	4·80	4·90	4·87	4 86
Moisture	12·59	12·46	12·50	12·51	12·55	12·56
Organic matter	10·85	11·12	11·10	11·19	11·08	10·98
	100·00	100·00	100·00	100·00	100·00	100·00
Dry matter	87·41	87·54	87·50	87·49	87·45	87·44
Specific gravity	1·466	1·467	1·467	1·467	1·466	1·466
Colour	3	3	3	3	3	3
Brightness	Bright	Bright	Bright	Bright	Bright	Cloudy
Taste	Full	Full	Full	Full	Full	Full
Acidity	0·072	0·075	0·080	0·080	0·091	0·094

COMPARISON OF FUEL VALUES.

Published records of tests of the heating value of petroleum, or "oil," as it is commonly called, indicate that one pound of oil has an average heating value of about 21,000 British thermal units. Four tests were made, and the results published on the authority of Favre and Silbermann, in the Proceedings Inst. Mech. Engineers, 1899, showing the heat units in two grades of Russian oil, one of petroleum refuse and one of Pennsylvania crude oil; the average of the four shows 21,180 B. T. U. per pound. Prof. J. E. Denton published an analysis of Beaumont oil that showed a value of 19,060 B. T. U. per pound.

For the purposes of this article a fuel value of 20,000 B. T. U. per pound of oil may be safely assumed.

The representative of one of the oil companies in Honolulu has stated it is proposed to supply this market with oil at an average density of about 16° Baume; this has a Sp. Grav. of ·9589 and weighs 7·99 lbs. per gallon. The Beaumont oil has a Sp. Grav. of ·920, a density of 22° Baume, and weighs 7·66 lbs. per gallon.

Assuming the density of the oil supplied here to lie between 16° and 18° Baume, the average weight will be 7·93 lbs. per gallon, and 42 gallons, or a barrel, will weigh 333 lbs.

At the Western Sugar Refinery in San Francisco, the average equivalent evaporation per pound of oil from seven different burners was 11·29 lbs. of water, and the burner giving the best results of 13·85 lbs. water per pound of oil was adopted throughout the plant.

An every day evaporation of 13 lbs. of water per pound of oil involves an efficiency of 65%, and this is not startingly low considering the comparatively small attention that engineers and firemen in general have given to the question. It is quite likely that when the use of oil as a fuel has received the attention it deserves the efficiency will be brought up to 80%, a figure that is now assumed by some writers.

The heating value of coal lies between 10,000 and 16,000 B. T. U. per pound, and depends on the proportions of fixed carbons and volatile matters as well as the combined moisture and ash. The average of a number of trials made in these islands during the past two years, with hand firing, shows an evaporative effect of slightly over 8·00 lbs. of water per pound of coal. Mechanical stokers gave slightly better result.

These trials were made under more or less expert attention, and it would not be safe to assume that 8·00 lbs. of water per pound of coal could be evaporated under every day working conditions. No serious fault should be found with the ordinary Japanese fireman if he is getting an evaporation of 7·50 lbs. per pound of coal in general use here.

Mr. C. F. Eckart, director of the experimental station, has kindly furnished the writer with an analysis that is an average or mean of a great many analyses of bagasse. It may, perhaps, be taken as a fair sample of bagasse throughout the islands, but should not be considered a suitable figure for making final determinations in any particular case. This average analysis is as follows: Sucrose 4·56%, glucose 1·5%, fibre 48·66%, ash 1·5%, and water 43·78%. There are also traces of some gums that are probably hydro-carbons, but of such small quantities they may be disregarded. The chemical analyses of these component parts are: sucrose, C-12, H-22, O-11; glucose, C-6, H-10, O-5; fibre, C-6, H-10, O-5; water, H-2, O-1; and by resolving these with their respective percentages, the fuel value is shown to be 3,500 B. T. U. per pound of bagasse. If all these heat units could be utilised there would be an equivalent evaporation of 3·62 lbs. of water for each pound of bagasse burned. It should be easily within range to burn bagasse with an effici- units could be utilised there would be an equivalent evaporation of 3·62 lbs. of water for each pound of bagasse burned. It should be easily within range to burn bagasse with an efficiency of 65%; there are boiler settings here that are probably giving better results than this. This will serve, however, to illustrate the point of this article. Burning this average bagasse at 65% efficiency will evaporate 2·35 lbs. water per pound of bagasse, and the following comparisons may now be drawn on the bases laid down:—

One pound bagasse will evaporate 2·35 lbs. water.
One pound coal will evaporate 7·50 lbs. water.
One pound oil will evaporate 13,000 lbs. water.

The above shows that as fuel values
One pound bagasse equals ·18 pounds oil.
One pound bagasse equals ·314 pounds coal.
One pound coal equals ·576 pounds oil.
One pound coal equals 3·19 pounds bagasse.
One pound oil equals 1·73 pounds coal.
One pound oil equals 5·35 pounds bagasse.

Giving expression to these values in purchase quantities:
One barrel oil equals ·288 tons coal, or 576 lbs.
One barrel oil equals ·92 tons bagasse; 1840 lbs.
One ton coal equals 3·19 tons bagasse.
One ton coal equals 3·46 barrels oil.
One ton bagasse equals 1·08 barrels oil.
One ton bagasse equals ·314 tons coal.

Relative money values in evaporation of water with oil at $1·00 per barrel:
Coal is worth $3·46 per ton of 2,000 lbs. and
Bagasse is worth $0·92 per ton of 2,000 lbs.

The relative money values of coal and bagasse may easily be found as the percentage of actual cost over the assumed price of $1,000 per barrel: For example, if the oil should cost $1·60 delivered to the plantation, it has the same fuel value as coal at $5·54 per ton of 2,000 lbs, and the bagasse has a fuel value of $1·47 per ton.

With coal at $1·00 per ton of 2,000 lbs. oil is worth $0·288 per barrel, and bagasse is worth $0·31 per ton of 2,000 lbs. In same manner as above the true result may be obtained by the percentage of true over the assumed cost of coal. Say coal costs $8·50 per ton at the plantation, it has the same value as oil at $2·45 per barrel, and the bagasse is worth $2·63 per ton.

No mention has been made of the comparative costs of handling the different fuels or the convenience of one over the other: conditions and locality decide these things. This is merely for the purpose of showing a comparison of the fuel values of bagasse with that of coal and of oil, apropos of the recent mention of the use of this "trash" of paper pulp and that these proportions and relative values may afford some data upon which the price of bagasse may be based to return some profit to the plantations.—(E. P. JONES, in *Hawaiian Planters' Monthly.*)

SUGAR CANE EXPERIMENTS IN THE LEEWARD ISLANDS, 1901-02.*

The experiments with varieties of sugar cane conducted during the season 1901-2 followed the lines adopted in the previous year. As in former years, the canes were crushed in a Chatanooga mill, both in Antigua and in St. Kitt's; as these mills take the canes without their being previously split or otherwise manipulated, they give results which are fairly comparable with the mills in use on the estates, except that the amount of juice expressed in these experiments is probably much greater than is obtained in practice from the mills in this Colony. As care is taken to avoid any alteration in the setting of the mill during the course of the season's work, it is possible to compare the quantity of juice yielded by each kind of cane under experiment, and interesting results have been obtained in this way. As different mills, though identical in pattern, are in Antigua and St. Kitt's, strict comparison cannot be instituted between the proportion of juice obtained from the canes in the two Presidencies; efforts, however, were made to secure conditions as similar as possible.

* Summarized from Report issued by Department of Agriculture for the West Indies.

ANTIGUA.

Plant Canes.—Experiments with plant canes were conducted in duplicate, on seven stations instead of on six as in the previous year, a new station being laid out at Friar's Hill.

The average annual rainfall on the cane-growing districts of Antigua is 46 inches. The present season up to March, 1902, was therefore an extremely favourable one for cane growing. Unfortunately from April to July heavy rains fell, making the reaping season one of unusual difficulty.

The main collection of plant canes was cultivated at Cassada Garden estate, as in the previous season, and this year included thirty-one selected varieties. On the remaining six stations twenty-three selected varieties were grown, being the fourteen varieties grown last year, together with some newly introduced kinds. These were White Transparent, Naga B., Caledonian Queen, Mont Blanc, Rappoe, B. 109, B. 147, D. 95, D. 102, D. 115, D. 116, Queensland Creole (or Purple Transparent), Burke and Red Ribbon, being the varieties previously experimented with, the following being the nine varieties added to the list: B. 208, B. 156, B. 306, B. 176, Sealy Seedling, D. 130, D. 74, D. 145, D. 78.

Table I. contains information of the greatest interest to the general reader, as it gives the means of the results obtained at all the Antigua stations. In the individual experiments there is fair agreement concerning the merits of the various canes under experiment, the series at Thibou's departing more from the average than most of the others.

The figures given in Table I. enable us to institute interesting comparisons between the twenty-three varieties of cane under experimental cultivation. In the table the canes are arranged in order according to the yield of sucrose in the juice per acre.

B. 208 heads the list, and presents several good qualities: the juice is exceptionally rich in sugar, having, as the average of these experiments, 2·163 lb. sucrose per gallon of juice. Reference to the figures of the individual experiments shows that the glucose and non-sugars were low in all cases, so that there is good reason for believing that this cane is one which may be safely recommended. This idea is confirmed by the fact that it has also done well in St. Kitt's. Similar good results have been obtained in Barbados and Trinidad. This confirmatory evidence is satisfactory, and warrants our drawing the attention of planters to this cane as one which we feel can be recommended for cultivation with some degree of confidence, always remembering that caution is necessary in the introduction of any new variety of cane.

D. 95 ranks next in saccharine richness; it has given very large returns in some instances, and appears to be well suited for moderately heavy soils. The juice is usually characterised by its exceptional purity. This cane, too, deserves careful attention at the hands of the

planters. In last year's experiments it stood first in the list in Antigua, and this year is only surpassed by new canes, B. 208, D. 130, and B. 109. The position of the latter this year may be abnormal.

A word of caution is perhaps necessary with respect to B. 109. The season under review was one in which the rainfall was above the average, and there is some suspicion that B. 109 owes its high position this season to the high rainfall, seeing that in previous years it has occupied a low position. This cane has this year given the largest yield of juice per ton of cane, namely, 166·6 gallons per ton, and this perhaps also points to its being influenced by the large rainfall, as in previous years it afforded much less juice: it has also given the heaviest tonnage of cane per acre, but the juice was not rich in sugar, containing the smallest quantity (1·460 lb. per gallon) of any of the canes in this series.

The Burke cane was at one time largely grown in Barbados, but was soon abandoned on account of its unsatisfactory yield, and particularly the low sugar content of its juice. It has however done very well in Antigua for several years under experimental cultivation. During the years this cane has been under experimental cultivation in Antigua it has afforded juice having the following sucrose content:—

		Lb. sucrose per gallon.
1897 ..	1 plot plant cane	1·775
1900 ..	mean 12 plots plant cane	1·902
1901 ..	,, 12 ,, ,, ,, ...	1·952
1901 ..	,, 6 ,, ratoon ,, ...	1·966
1902 ..	,, 14 ,, plant ,, ...	1·806
1902 ..	,, 10 ,, ratoon ,, ...	1·831

Turning to the Barbados reports we find the following record of this cane: in most cases the result is derived from the analysis of a single sample only:—

Year.	Sucrose per gallon.	Year.	Sucrose per gallon.	Year.	Sucrose per gallon.
1891	1·84	1894	1·63	1897 . ..	1·62*
1892	1·32	1895	1·69	1898	1·75*
1893	1·75	1896	1·68	1899	1·56

In putting forward these figures it is not suggested that planters should plant Burke canes largely, for at present there are several better canes within their reach. What is suggested is that new varieties of cane may be somewhat variable, that indifferent qualities may become fixed in certain districts, while better and desirable qualities may become fixed in others, and thus at the end of a given period the canes in the two districts may show permanent differences of character. A case of this kind seems to exist in the two strains of Burke canes grown in Barbados and Antigua respectively.

* Mean of several analyses.

If the facts are as suggested, then great importance attaches to the pedigree of any variety of cane to be introduced, as there may be more than one kind or strain of cane resulting from one original seedling. For some time something of this kind has been suspected by the experiment station workers in Antigua, and planters have been urged to exercise care in obtaining new supplies of canes, and to obtain these from a stock which has been proved to do well in, or near, their own districts. When a new cane attracts attention in a district, or Colony, there may be some risk of purchasing a cane, bearing the same name, from a distant district, or Colony, and planters are cautioned against this.

It would be well if the records of our experiment stations were examined, in order to see if similar cases could be discovered and brought to light.

B. 147, which has attracted much attention and given rise to some controversy in other places, again occupies a low position in the Antigua experiments.

TABLE I.

PLANT CANES.

MEANS REDUCED FROM 14 PLOTS OF EACH VARIETY OF CANE.

No.	Name of Cane.	Cane.	Juice.		Sucrose.	
		Tons per acre.	Gallons per acre.	Gallons per ton.	Pounds per gallon of Juice.	Pounds per acre in Juice.
1	B. 208	43·3	6,145	145·3	2·163	13,293
2	*B. 109	47·0	7,831	166·6	1·460	11,974
3	D. 130	41·5	5,930	142·9	1·925	11,413
4	D. 95	37·0	5,439	147·0	2·047	11,132
5	Sealy Seedling	41·1	5,856	142·5	1·886	11,047
6	D. 102	42·6	5,451	128·0	1·890	10,349
7	Naga B.	36·0	5,746	142·9	2·011	10,348
8	Burke	38·6	5,716	148·1	1·806	10,321
9	B. 156..	40·3	5,700	141·5	1·803	10,276
10	B. 306	32·9	4,832	148·6	2·094	10,236
11	D. 74	37·1	5,247	141·4	1·891	9,923
12	Caledonian Queen ..	34·4	4,997	145·3	1·934	9,665
13	Mont Blanc	34·5	4,942	143·2	1·915	9,462
14	D. 115..	36·1	5,015	138·9	1·857	9,341
15	Rappoe	35·2	5,034	143·0	1·851	9,318
16	D. 116..	33·5	4,732	141·3	1·878	8,889
17	*D. 145	33·2	4,822	145·2	1·839	8,868
18	Red Ribbon	31·5	4,537	144·0	1·908	8,655
19	D. 78	34·8	5,189	149·1	1·663	8,627
20	White Transparent..	30·6	4,451	145·5	1·924	8,566
21	*B. 147..	29·1	4,210	144·7	1·978	8,327
22	Queensland Creole ..	30·1	4,277	142·1	1·937	8,285
23	B. 176..	22·5	3,215	142·9	1·840	5,916

* Mean of 13 plots only.

Table II.

RATOONS.

Means Reduced from 10 Plots of each Variety of Cane.

No.	Name of Cane.	Cane.	Juice.		Sucrose.		Position as Plant Cane.
		Tons per acre.	Gals. per acre.	Gals. per ton.	Pounds per gallon of Juice.	Pounds per acre in Juice.	
1	D. 95	30·9	4,439	143·6	2·015	8,946	1
2	Red Ribbon	28·2	3,944	139·9	1·939	7,647	6
3	Caledonian Queen ..	28·5	3,914	137·3	1·952	7,641	9
4	Mont Blanc	28·1	3,854	137·2	1·969	7,588	2
5	White Transparent ..	26·7	3,789	141·9	1·940	7,349	7
6	Naga B.	25·7	3,597	140·0	2·012	7,238	3
7	Burke	27·9	3,904	139·9	1·831	7,147	4
8	D. 102..	27·3	3,784	138·6	1·838	6,955	5
9	D. 115	26·8	3,638	135·7	1·902	6,914	14
10	D. 116..	27·4	3,741	136·5	1·845	6,901	13
11	Rappoe	25·9	3,614	139·5	1·898	6,823	10
12	B. 109..	25·1	3,615	144·0	1·872	6,767	11
13	Queensland Creole ..	24·7	3,473	140·6	1·916	6,656	8
14	B. 147	21·4	3,097	144·7	1·883	5,831	12

Ratoons.—It is instructive to compare the positions occupied by the canes as plants and ratoons on each plot. On the whole it will be seen that the canes which have done best as plant canes have also ratooned well. Owing to a favourable growing season the plots have afforded larger yields of sugar with ratoon canes than they did last year as plant canes.

Table II., showing the average return from all the ratoon plots, contains much instructive information. D. 95 has proved a good ratooning cane, occupying the first position; while B. 147 falls to the last place. Red Ribbon has done well, occupying the second position, with excellent juice containing 1·939 lb. sucrose per gallon. The closely allied, or possibly identical, canes, Caledonian Queen, Mont Blanc, White Transparent, and Naga B., all fall together with only an extreme variation of 223 lb. sucrose per acre between them.

St. Kitt's.

Plant Canes.—The experimental cultivation of selected varieties of sugar cane was conducted upon the following estates in St. Kitt's:—La Guerite, Buckley's, West Farm, Con Phipps, Estridge's, Molyneux, and Canada. The canes were cultivated after the usual methods followed in this island, and in the same manner as the rest of the fields of which they formed part.

B. 208 comes first on the average results this year as last, thus again establishing its claim for careful consideration at the hands of planters, who are recommended to plant small areas with this variety. The juice of this cane is of remarkable richness and purity. The high position taken by the Caledonian Queen cane is due to the exceptionally large returns obtained at Con Phipps. D. 95 has risen to the third place, but in dealing with this it must be remembered that the rainfall of the season was above the average. This cane may not do so well on the light soils of St. Kitt's when the growing season is at all dry; it should be introduced with caution, and preferably in places where the rainfall is usually high: it is worth trying in the higher fields where the rainfall is greater. As on previous occasions, so again this year, the juice of this cane is characterised by its remarkable richness and purity, features which distinguish these two canes B. 208 and D. 95 from all the others at present under experiment. B. 147 stands eleventh. This cane has given large returns when grown on an extensive scale in some districts in St. Kitt's, in which it seems to thrive. It is a late ripening cane, and until it is ripe the glucose ratio of the juice is often very high. Reaping operations should be commenced cautiously, and where the requisite tests can be made it is well to ascertain the glucose ratio of the juice from time to time, in order to learn when reaping may safely begin. When quite ripe the glucose ratio is comparatively low.

Ratoon Canes.—After the plant canes, which were reported upon last season, had been reaped the stools were treated in the usual manner, and crops of ratoon canes were raised. These were reaped under experimental conditions.

B. 208 gives a return practically identical with that of D. 95, and as the cane has given good results in all our experiments, and also in places outside the Leeward Islands, and as it also shows vigour as a ratooning cane, it can be recommended to planters as a cane suitable for fairly extensive cultivation. In this group again attention may be drawn to the great richness and purity of the juice afforded by the two canes D. 95 and B. 208. B. 147 has ratooned well. Taking all the circumstances into consideration, it would appear that this cane will do well on the deep light soils of St. Kitt's, and that it is more suitable for St. Kitt's than for Antigua, where the soil is much heavier.

Table III.

Means Deduced from 7 Plots of each Variety of Plant Cane.

No.	Name of Cane.	Cane.	Juice.		Sucrose.	
		Tons per acre.	Gallons per acre.	Gallons per ton.	Pounds per gallon of Juice.	Pounds per acre in Juice.
1	B. 208‡	36·6	4,793	130·9	2·165	10,378
2	Caledonian Queen* ..	38·6	5,093	132·0	1·907	9,714
3	D. 95	32·3	4,357	134·9	2·156	9,402
4	D. 116	38·1	4,997	131·2	1·820	9,095
5	Mont Blanc	37·7	4,942	131·1	1·839	9,089
6	B. 393	35·0	4,595	131·3	1·971	9,057
7	D. 74	35·4	4,557	128·7	1·933	8,849
8	D. 115	37·8	4,907	130·2	1·834	8,796
9	Naga B.	35·8	4,806	134·3	1·829	8,789
10	White Transparent ..	36·2	4,739	130·9	1·831	8,677
11	B. 147	37·5	4,673	124·0	1·840	8,597
12	B. 306†	32·6	4,592	140·9	1·859	8,538
13	Queensland Creole ..	36·3	4,638	127·8	1·821	8,445
14	Rappoe	32·5	4,364	134·3	1·766	7,708
15	B. 109†	30·7	4,073	132·7	1·879	7,652
16	Jamaica‡	33·3	4,447	133·5	1·698	7,552
17	B. 376	32·8	4,349	132·6	1·688	7,172
18	B. 254†	26·6	3,388	127·4	2·092	7,086
19	Burke	29·0	3,688	127·2	1·684	6,209
20	B. 176†	23·1	3,154	136 5	1·861	5,871

* Mean of 4 plots only. † Mean of 6 plots only. ‡ Excluding Canada.

Table IV.

RATOONS.

Means Deduced from 6 Plots of each Variety of Cane.

1	D. 95	33·9	4,697	138·6	2·156	10,126
2	B. 208	34·0	4,631	136·2	2·179	10,090
3	Naga B.	35·4	4,766	134·6	1·934	9,217
4	D. 74	31·3	4,282	136·8	2·047	8,767
5	B. 147..	32·9	4,484	136·3	1·913	8,577
6	Jamaica	33·1	4,244	128·2	1·994	8,464
7	B. 306..	29·9	4,147	138·7	2·033	8,431
8	D. 115	35·3	4,539	128·6	1·809	8,211
9	D. 116..	31·6	4,200	132·9	1·875	7,875
10	White Transparent ..	32·5	4,309	132·6	1·817	7,829
11	Rappoe	31·7	4,268	134·6	1·833	7,821
12	Burke..	31·3	4,179	133·5	1·864	7,790
13	Mont Blanc*	30·5	3,960	129·9	1·940	7,683
14	B. 376..	30·6	4,189	136·9	1·720	7,206
15	B. 393	27·8	3,775	135·8	1·853	6,995
16	B. 109..	29·4	3,749	127·5	1·809	6,782
17	Queensland Creole ..	27·7	3,672	132·6	1·839	6,753
18	B. 254*	26·7	3,489	130·6	1·898	6,623
19	B. 176	27·5	3,467	126·1	1·907	6,611
20	D. 145..	21·5	2,958	137·6	1·746	5,165

* Mean of 5 plots only.

RECENT PRACTICE IN THE DESIGN, CONSTRUCTION, AND OPERATION OF RAW CANE SUGAR FACTORIES IN THE HAWAIIAN ISLANDS.

On December 19th last, an interesting paper on "Recent Practice in the Design, Construction, and Operation of Raw Cane Sugar Factories in the Hawaiian Islands," was read at a meeting of the Institution of Mechanical Engineers in London, by Mr. J. N. S. Williams, of Maui, Hawaiian Islands. We reproduce below the chief parts of the paper, for which we are indebted to the official copy published by the Institution of Mechanical Engineers. And for a large number of diagrams and photos illustrating the paper as well as for an appendix containing samples of working sheets, we must refer our readers to that Official Report.

The rise of the cane-sugar industry in the Hawaiian Islands may be dated from the year 1876, when a reciprocity treaty between the Governments of the United States of America and the Kingdom of Hawaii permitted the entrance of Hawaiian raw sugars into the United States free of duty. About that time the labour laws of the Hawaiian Kingdom facilitated the entry of Asiatic labourers under contracts to the plantations for terms of years, whereby plantation owners and managers were enabled to produce cane very cheaply.

Twenty years ago the average yield of commercial sugar was about 9lbs. per 100 of cane, and the average yield of cane per acre was about 25 tons. At the present day the average yield of commercial sugar is about 12 lbs. per 100 of cane, and the average yield of cane per acre is about 40 tons. The above averages are taken over the whole group, but there are individual plantations of great size where the average yield far exceeds the above figures.

A detailed history of the steps in improvement in cultivation and manufacture of cane and sugar in the Hawaiian Islands during the past twenty-five years is beyond the scope of the present Paper, which describes the design, construction, and operation of the new sugar factory for the Hawaiian Commercial and Sugar Co., incorporated in San Francisco about twenty-five years ago. This company acquired from the Hawaiian Government an immense tract of land with its pertaining water-rights on the Island of Maui, and erected a sugar factory, which was then one of the finest in operation, making upwards of 100 tons of raw sugar daily.

With the lapse of years and change of conditions, it became necessary to remodel the systems of work to meet the altered circumstances, and the old factory being no longer adapted to handle the greatly increased crops, the task of designing and constructing the new sugar-house was placed in the hands of the Honolulu Iron

Works Co., of Honolulu, an old established concern, whose intimate acquaintance with the requirements of the case, and previous successes in the construction of modern sugar factories, warranted the confidence placed in them by the Board of Directors of the Hawaiian Commercial and Sugar Co. The factory is designed to grind a maximum of 3,600 tons of cane per day of twenty-four hours, which quantity of cane, when at its best, will yield about 550 tons of commercial sugar of about 96 per cent. pure sugar, The amount of cold water required for the condensers of the vacuum evaporating and graining apparatus in the plant will reach 9 million gallons per day; as this amount of water is sufficient to irrigate some 800 acres of cane, it became necessary to so situate the buildings that this water, after having been used in the factory, could be turned into the irrigating ditches below the mill site.

The new works were laid out on a piece of waste land near the centre of the plantation at an elevation of 73 feet above the sea, about one and a half miles from the port, and 15 feet below one of the principal irrigating canals, whence the supply of water for the condensers is drawn; the plot has a 1 per cent. gradient to and from the buildings, the surface soil being volcanic, mixed with huge boulders, and the underlying stratum is an old lava flow of considerable depth, thus furnishing a site which not only met all the surface conditions, but gave a foundation for the buildings and machinery that could not be surpassed.

Buildings.—The buildings are of steel construction, covered with corrugated iron, and occupy a space approximately 300 feet by 400 feet square; the grinding mills have each their own house, the houses extending over the boiler plant; the clarification, filtration, concentration, and graining apparatus are contained in two buildings side by side, each having the requisite floors and supporting columns for the machinery designed and built in with the main structure. The columns are all carried upon concrete foundations built upon bed rock, none of these foundations being loaded to more than 3 tons per square foot at the base, the outer columns of building being carried upon a continuous wall of concrete, on the outer side of which gutters 3 feet wide and 1 foot deep are fixed to carry off the rainfall on the roofs. The ground floor of the building is of concrete, 6 inches thick, in which are situated all the necessary drains and gutters for washing down the various apparatus. The buildings are lighted by glazed sashes on the sides and ends, and fixed skylights in the roof, some 30 per cent. of roof surface being skylight, and some 25 per cent. of vertical surface being glazed; the sashes do not slide, but open by swinging on trunnions, a form of construction that should not be used where severe rain-storms, accompanied by high winds, occur, as the sashes cannot be kept water-tight. The buildings are painted with a neutral tint graphite paint inside and outside, while the exterior

surface of the roof is painted with a mixture of coal tar and red lead put on boiling hot.

Machinery and Apparatus.—The machinery and apparatus, when complete, will consist of—

3 sets of crushing mills, each of capacity to grind 1,200 tons of cane per twenty-four hours.

20 boilers with individual furnaces and fuel feeders.

2 sets of conveyors and carriers for elevating and distributing the cane refuse to the furnaces.

Clarification plant.

Filtration plant.

2 quadruple effet evaporators of the Lillie system.

6 vacuum pans, each capable of making 100 tons of dry sugar per day.

30 crystallising tanks, of the Bock system.

20 centrifugals.

Elevators, conveyors, and bagging apparatus for handling the finished product.

The cane as it is cut in the field is loaded upon cars, 7 feet wide by 12 feet long, each having four wheels and running on tracks of 3 feet gauge; the end of the cars are boarded up, and each side is formed of three removable stakes set in sockets so designed that the stakes are readily cast loose. After passing the scale house where each car-load of cane is weighed, the cars are brought up to the cane carrier, one on each side; the inward stakes are removed and the cane discharged by the automatic cane unloader, which consists of a triangular framed structure carrying four moving endless chains with fingers, and capable of being raised to allow a car-load of cane to pass under, and then lowered until the fingers or rakes on the chains reach the cane and pull it off the cars in such quantity as may be needed. There are two of these cane unloaders, one on each side of the cane carrier, and the combined action of the two is sufficient to unload the cane as fast as the crushing apparatus can receive it.

Crusher and Mills.—The cane being discharged on the carrier is conveyed forward and upward until it reaches the preliminary crusher, which consists of two rollers, 26 inches diameter by 72 inches long, set vertically one above the other. These rollers are of solid cast steel and have zigzag grooves about 2 inches deep and 6 inches pitch, running lengthwise of the rollers; these grooves or teeth mesh into each other, draw in the cane, partially crushing it, and partially cutting it up into about 6 inch lengths; after passing the crusher, the mass then slides down an iron apron into the jaws of the first three-roller mill, where it is crushed under a pressure on the top roller of 230 tons applied by hydraulic rams acting on the brasses of the top roller. After passing this mill, the crushed cane is sprayed with hot water, and carried by an endless apron conveyor, made of

steel slats on chain belting, to the jaws of the second mill, which is a duplicate of the first but operating under a pressure of 320 tons on the top roller. The crushed cane, on being discharged from the second mill, is again sprayed with hot water, and by a travelling apron, a duplicate of that between the first and second mills, is conveyed to the jaws of the third mill, which is of the same size as the first two, and operated under 400 tons on the top roller; here the cane gets its final crushing, discharging the bagasse in the condition of fine shreds containing from 44 per cent. to 48 per cent. of moisture and from 7 per cent. to 9 per cent. of the sugar originally in the cane.

The crushing mills consist of cast-iron rollers, 34 inches diameter by 78 inches long, keyed to hammered iron shafts, 18 inches diameter in the roller, and having journals 15½ inches diameter by 20 inches long; the rollers are carried in heavy cast-iron housings fitted with suitable bronze bearings; the returner bar is a very strong cast-iron beam, pivoted on trunnions at the bottom of the housings, and drawn up against the front roller by two large bolts which extend outside the housings, so as to be easily accessible. Since this returner bar or knife is what passes the crushed cane from the front roller to the back roller under the top roller, it is subjected to very heavy strains, and requires careful adjustment to avoid setting up undue friction.

The mills and crusher are operated by one Corliss engine, cylinder of 30 inches diameter by 60 inches stroke, running at 44 to 54 revolutions per minute. The speed of the engine is reduced through a train of compound gearing very strongly constructed, the pinions of which are of cast-steel, and the wheels having cast-steel solid rims bolted to cast-iron spiders, the pinions being shrouded to the tops of the teeth, while the wheel teeth are bare. The first motion pinions and spur wheels have teeth 4½ inches pitch by 14 inches face, the second motion pinions and spur wheels have teeth 4½ inches pitch by 18 inches face, all mounted on hammered iron shafts, carried in cast-iron pillow-blocks which are lined with Babbit metal. The proportion of the gearing is such that, when the engine is running at 45 revolutions per minute, the peripheral speed of the crusher rollers is 28 feet per minute, that of the first mill is 20 feet, the second mill 23 feet, and the third mill 26 feet per minute. The object in thus giving increased peripheral speed to each mill in the train is to reduce the thickness of the blanket of crushed cane going through each mill in the series, so that the increased pressure upon the top roller in each mill acts upon a thinner blanket and thus produces a better extraction with a given pressure.

Bagasse Conveyors.—The refuse of the cane, or bagasse, after leaving the last mill is received on an inclined elevator, consisting of link belt chains connected by wooden slats or scrapers, which catch the bagasse as it leaves the mill and elevate it up to a horizontal conveyor at a height of about 25 feet above the floor and inside the

boiler-room, This horizontal conveyor runs across the building, and is designed to serve the two longitudinal carriers which distribute the bagasse to the furnace feeders.

Boilers.—For the ultimate capacity of the sugar-house there will be required 20 boilers, of which 14 have been placed. These boilers are 7 feet diameter by 20 feet long, furnished with 118 tubes, 4 inches outside diameter; heads are $\frac{5}{8}$ inch thick, shells $\frac{9}{16}$ inch thick with treble-riveted butt joints, designed to carry 125 lbs. pressure of steam. They are arranged in two lines—ten on one side and four on the other; the boilers are set in brick, with a special furnace in front of each one designed for burning the low grade fuel furnished by the cane. The grate surface as originally designed was 49 square feet for each boiler, but it had been reduced to 36 square feet with very beneficial results. The heating surface of the boilers is 2,600 square feet for each, and ratio of grate surface to heating surface was 1 to 53, but is now 1 to 72. Each battery of boilers is served by a steel chimney lined with brick; height of chimney above lower grate bars 180 feet, diameter of chimney inside lining 11 feet 10 inches, the connection from boilers to chimney being made by a sheet-iron flue lined with brick. The temperature of the waste gases leaving the boilers is approximately 450° F.

Furnaces.—These furnaces are of the Dutch oven type fitted with a combination of grate bars set above one another in a series of steps across the furnace, the angle of incline being 47° with the horizontal, and ordinary grate bars situated at the foot of the incline running lengthwise of the furnace. The furnace as originally made is 5 feet 9 inches wide, having 23 step-ladder bars, supported at foot by a heavy transverse bearer, which also supports the flat ordinary bars of 2 feet 2 inches length. The reducing of the grate surface was accomplished by building up the ash-pit on each side underneath the step-ladder bars to a width of 4 feet. Strictly speaking, this is not a reduction of grate surface, since the surface for the reception of the fuel remains as originally designed, the actual reduction taking place in the area of the air-passages through the bars; it is however at this stage more convenient to refer to the matter as a reduction in the grate surface.

On the top of the furnaces are situated the bagasse feeders, which are iron boxes connected to the shoots coming from the overhead carrier, and in which are placed iron flap-doors, so arranged that the opening to the furnaces for the delivery of bagasse can be adjusted at will. The bagasse being delivered from the inclined elevator from the mills, to the horizontal cross conveyor in boiler-house, is then conveyed and delivered into the longitudinal distributing conveyors over the furnaces. These conveyors have in the floor of the trough an arrangement of doors sliding across the trough, closing in the middle and opening both ways from the centre over each furnace, and

operated from the firing floor; and by manipulating the opening of these doors, the supply of bagasse to each furnace is regulated. Under each of these doors is a two-legged shoot, one leg delivering to the furnace feeder, and the other to the floor for surplus bagasse, a flap in the shoot operated by a lever and chain throws the whole or any part of the bagasse either to the furnace or the floor. The bagasse falls in a steady stream on the sloping grate surface beneath the outlet from the feeder, and rolls down the incline, burning as it falls, resting finally on the foot grates where the most intense heat is generated, and where the ash and slag formed by the combustion of the bagasse remains until removal. The ashes and slag are removed from below the grate bars, and taken out through the air-passage to the furnaces underneath the firing floor.

Juice.—The juice expressed from the cane by the action of crusher and mills falls into the receiving pan underneath the mill housings, and runs thence to an automatic screening apparatus, consisting of a chain elevator having slats which drag across a brass screen 14 inches wide and 10 feet long, pierced with 144 holes per square inch, holes about $\frac{1}{25}$th inch diameter; the screened juice falls through the screen into a receiving tank capable of holding 1,000 gallons, and is pumped from thence up to the juice-weighing machine, which is situated over the liming tanks on the same level as the vacuum pans, while the screenings are taken up by the slats and delivered back to the mill for recrushing. This apparatus is driven from one of the second motion shafts in the gearing of the mill. The juice then passes over the weighing machine, is weighed in parcels of about 400 lbs., sampled, and then dropped into the liming tanks, where it is treated with lime and other reagents, and then pumped through a high-pressure heater, where it is brought up to about 230° F. under the corresponding pressure, cooled down to 205° F. in a tubular cooler, which admits of cold juice being pumped through in one direction while the hot juice is being pumped through in the opposite, the cold juice taking up the surplus heat in the hot juice, thus effecting an economy of heat.

After passing the heater, the juice is discharged into a series of settling tanks, where it is allowed to stand until the impurities settle out, when the clear juice is drawn off into a receiving tank for juice filters, and the settlings, after being diluted with water and further treated with lime and reagents, are drawn off into a receiving tank for the filter presses, when the solids are finally separated from the clear juice they held back; the solids are discharged into the sewer to be mixed up with the irrigating water and used as fertilizer for the cane fields, while the clear juice is discharged into a receiving tank for the evaporator. The clear juice from the settling tanks is passed through sand filters, which consist of cylindrical tanks, set on end, with an internal tube covered with fine wire gauze, and the remainder filled

with ordinary sand, the juice percolating through the sand into the internal tube and thence to the receiving tank for the evaporator.

Evaporating Apparatus.—This is quadruple in effect, the first body which receives the thin juice being supplied with exhaust steam from the various engines in the sugar-house, under about 5 lbs. pressure. The steam given off from the thin juice in the first body is used in the second body to evaporate further the slightly thickened juice coming over from the first body, and so on to the fourth body, which works under 27 inches of vacuum; this vacuum is produced by the condensation of the vapours given off from the syrup in the last body, a powerful vacuum pump being connected to the condenser to draw off air and uncondensable gases, which come over with the vapours from the juice or, as it is now called, syrup. The juice containing some 16 per cent. of solid matter in solution enters the apparatus, and is discharged containing some 60 per cent. of solid matter; this syrup is pumped up to the receiving tanks for the vacuum pans, having lost in the operation about 75 per cent. of the water originally contained in the juice. This water, which is delivered by the evaporating apparatus in a pure state, is used for feed make-up for the boilers, for washing down tanks, filters, &c., and for diluting the settlings from settling tanks and molasses when being treated for reboiling, the surplus going into the sewer, and out on the fields for irrigation. The evaporator in use has a forced circulation for the juices and syrups between the various bodies, and is furnished with 538 copper tubes, 3 inches diameter by 7 feet 4 inches long, corresponding to 3,050 square feet heating surface in each body, or a total heating surface of 12,200 square feet, evaporating for every pound of steam taken into the first body approximately 3·75 lbs. of water out of the juice, and approximately 5 lbs. of water per square foot of heating surface in the four bodies.

The evaporating apparatus is of the type known as film evaporators, since the juice under operation showers down over the heating surface in a spray, the steam being inside the tubes. The circulation of the juice over the heating surface, and from body to body, is maintained by a series of centrifugal pumps, one for each body, all driven by a high-speed engine directly connected to the shaft upon which the centrifugal pumps are mounted. The syrup is drawn off from the evaporator, and delivered into a receiving tank by the action of the circulating pump connected with the last body of the apparatus; from the receiving tank an independent steam pump draws the thick syrup and forces it up to storage tanks of about 25,000 gallons capacity situated on the vacuum pan floor, and at such a height that they drain to the pans. These tanks serve a main-supply pipe to which each vacuum pan is connected.

Vacuum Pans.—These pans are each 10 feet 6 inches diameter, with a conical bottom, straight belt 15 feet high and dome-shaped

cover, connected to the condensers by 48 inch cast-iron pipes, and are fitted with 1,000 square feet of heating surface each, divided over sixteen 2 inch copper coils, set 6 inches apart from coil to coil, and properly supported on iron beams, being held thereto by brass clamps; these admit of a certain amount of movement in all directions to accommodate the contraction and expansion of the coils. The coils are served by both live and exhaust steam, and drain into manifold pipes, whence the water of condensation from the steam used in the coils is drawn by pumps and delivered to the hot-well to be returned to the boilers. The delivery gate at bottom of pan is 30 inches diameter and is of the mushroom-head type, being operated by a worm and wheel from the upper platform, the final tightening being effected by a toggle operated by the same worm and wheel. The joint is made by a ring of hard rubber on the gate, which seats against a turned rim on the pan bottom; the ring is easily removed and replaced when worn, spare rings being carried in stock for the purpose. The pans are operated under 27 inches of vacuum, which is maintained by the vapours being condensed in a suitable jet condenser, to which is attached a powerful vacuum pump, the water used, together with the condensation of the vapours, escaping through a tail pipe out into the main sewer.

The masse-cuite, after being boiled and grained, is dropped into a receiving tank or mixer, to which are attached the centrifugal drying machines of the suspended type, having baskets 40 inches diameter lined with fine brass screens, and revolving at 1,000 revolutions per minute. Each machine is charged by opening a gate in the bottom of the mixer, and allowing a quantity of the masse-cuite to run into the baskets of the centrifugal machines, which are kept at a slow motion until sufficient material has been received. They are then brought up to speed in about one minute, the centrifugal force generated in the molasses driving it out through the screen, leaving the grained and dry sugar in the machine, which is then discharged through the bottom by raising a valve; the whole operation occupies about eight minutes, and the amount of dry sugar recovered per charge is 400 lbs., so that each machine dries 3,000 lbs. of sugar per hour.

These machines are driven by Pelton water-wheels,* 23 inches in diameter, mounted on the spindle just below the point of suspension, and are served by two nozzles delivering water under 180 lbs. pressure, one nozzle being to keep the machine at speed when attained, and the two nozzles to furnish sufficient pressure water to bring the loaded machine up to its maximum speed of 1,000 revolutions per minute in the space of about one minute. To effect economy of pressure water, after the maximum speed has been reached, one nozzle is shut off. The pressure water is furnished by

* Watson, Laidlaw & Co.'s Patent.

one large direct-acting pump delivering 1,000 gallons of water per minute into an air-chamber 60 feet high. It is found that the centrifugal machines require water under the steadiest possible pressure to get the best results; the air-chamber is accordingly charged with compressed air at 60 lbs. pressure before the water-pump is started. This gives a very long air-cushion in the head of the stand-pipe under 180 lbs. pressure, which corrects the irregularities due to slight variations in the speed of the supply pump, and gives time for the pump regulator to act in slowing down or speeding up to accommodate the machine service.

After the sugar has been discharged from the centrifugal machines it falls into a screw conveyor serving the battery of machines, and is conveyed to an elevator, which carries the sugar up above a large bin holding about 100 tons of sugar; the warm sugar falls on the vanes of a rapidly revolving fan, which scatters the sugar all over the bin, breaking up the lumps, separating the grains of sugar one from the other, and cooling it; the object of this is to improve its keeping qualities on the voyage from this country to San Francisco or New York, it having been found that sugars bagged warm are more liable to deterioration on a long voyage than those treated as above. From the bin, which has an inclined bottom, the sugar is drawn off through spouts, then it is bagged, weighed, and stored for shipment. An economy in labour is also effected, as by the use of the bin one man bags and weighs 50 tons of sugar in ten hours, whereas when the sugar has to be shovelled into bags from the floor it requires three men to do the same work.

The above sugars, being made directly from the syrup, are known as No. 1 sugars, and the molasses given off in the drying process is No. 1 molasses, which, on leaving the centrifugal machines, is caught in a tank, where it is diluted with water to melt out any small grain that may have escaped through the screens, brought up to boiling point, and pumped up to storage tanks on the vacuum pan floor; these tanks have some 18,000 gallons capacity, and are connected to the vacuum pans in the same way as the syrup tanks. This molasses is boiled in a vacuum pan to grain, and if it should be too poor in sugar, a little syrup is taken in with it to start a grain, and this grained molasses is then discharged into a similar tank or mixer to that used for No. 1 sugar, and dried in centrifugal machines of the same kind and size as those used for No. 1 sugar, but the resulting dried sugars are of a smaller grain and poorer quality, and cannot be operated upon in the same way as No. 1 sugars, and are, therefore, discharged on the floor, bagged, and weighed direct.

This sugar is known as No. 2, and rarely exceeds in quantity 95 per cent. of the No. 1 sugars. The molasses from this sugar is known as No. 2 molasses, and is treated in tanks in a similar manner to the No. 1 molasses, being pumped up to storage tanks of 12,000

gallons capacity, and, when sufficient has been accumulated, a boiling is made in one of the vacuum pans. This molasses is, however, very poor in sugar, and requires special treatment to obtain the crystals, failing which it cannot be marketed; it is boiled to a density of from 83 per cent. to 88 per cent. of solid matter, depending greatly upon the character of the solids in solution, and is then discharged from the pan to a crystalliser, which is a tank 9 feet in diameter by 20 feet long, fitted with an internal shaft and stirrers. It has been found that when crystals of sugar are formed in a poor molasses, if they can be kept moving about in the solution, they take up more pure sugar therefrom than if they remain stationary. Consequently, after the charge of molasses is in the crystalliser, the grain, which forms as the charge cools down, is kept in action by the action of the stirrers, which revolve very slowly; after having been in process for a period varying from eight to sixteen days, all possible sugar has been taken up—a point which is determined by drawing off samples of the contents of the crystalliser from time to time and analysing.

The crystallising tanks are situated above the mixer and centrifugals, and below the vacuum pans, so that a boiling of molasses descends by gravity to the crystalliser, and thence by gravity to the mixer.

This masse-cuite is dried in the same way and by similar machines to other grades of masse-cuite, but the resulting sugar which is of too low a grade to ship is drawn into the vacuum pan while boiling No. 1 sugar, and is thus converted into No. 1 sugar. This is done by putting the low goods dry into a conical buttoned tank connected with the vacuum pan by a short pipe and gate; by opening the gate, when vacuum is on the pan, the dry sugar is drawn in and immediately mixes with the grain already in the pan, care is taken that the grain in the pan shall be no larger than the grain to be drawn in, so as to avoid irregularities which would tend to affect the market value of the product. The molasses given off from the low goods from the crystallizer is carefully analyzed, and if so poor in sugar that it will not pay to reboil, it is discharged over a weighing machine, and is either burned in the furnaces with the bagasse, fed to stock with their green food, or mixed with irrigating water and run on the land as a fertilizer; if of a good enough quality it is mixed with No. 2 molasses and treated with it. Molasses has a definite calorific value, and careful observations have made it equal to bagasse as fuel. Three tons of bagasse containing 45 per cent. moisture are considered in the Hawaiian Islands as equal to one ton of ordinary Australian coal, consequently one ton of molasses properly burned is equivalent to one-third ton of ordinary coal. The burning of the waste molasses is accomplished in this factory by feeding it in thin streams on the bagasse as it is ejected from the last mill; the bagasse

soaks up the molasses in a very finely divided form, and it burns readily and produces a very hot fire in the furnaces already described. The amount of molasses burned varies from 60 to 200 gallons per hour, depending upon the rate at which the waste molasses comes forward.

When the molasses is used for fertilizing purposes it must be dissolved in about fifty times its volume of water, otherwise it may destroy the plant; it is not considered a very safe proceeding, but applied with care there is no doubt of the value of molasses as a fertilizer on certain lands.

The finished product is divided into two grades A and B.

Grade A includes all No. 1 sugar, and is high-class raw sugar having a hard clearly defined crystal, and of a purity of from 97 per cent. to 98·5 per cent. This sugar does not deteriorate in transit to market, if care in manufacture has been taken; as a rule it will dry out somewhat, losing slightly in weight, but this is compensated for by the rise in purity which is usually in the proportion of the drying out.

Grade B includes all low-class sugars, whether made from syrups or molasses; the crystal is soft, is not clearly defined, and the purity ranges from 93 per cent. to 96 per cent.; this sugar will lose in weight and polarization in transit, owing to the tendency to sweat and ferment, due to the poor grade material from which this sugar is made.

The sugars are put up in 125 lb. bags, and are loaded at the sugar-room on flat cars, 200 bags to the car, for transit to the port, where they are loaded on scows from which they are shipped.

Electric Lighting Plant.—The factory is served by a 50 kilowatt Westinghouse generator, driven by a direct-connected Westinghouse standard engine; the full load of the machine is 400 ampères at 110 volts. There are eight separate circuits, each having its own switch on the switchboard; the plant is fitted with lightning arresters, automatic circuit breakers, and the most modern types of fittings. The wiring throughout the factory is of extra heavy insulated copper wire carried on wooden bolsters bolted to the steel columns of the structure; the factory is fitted with 700 16 candle-power incandescent lamps, the outside circuits serving the storage tracks for cane have 40 100 candle-power incandescent lamps on poles, 24 feet high, set at 75 feet apart, the light from the lamps being concentrated by conical hood reflectors, which direct the light downwards in a belt some 100 feet wide along the line of switches of the storage tracks. Incandescent lamps are used in preference to arc lamps, mainly because the small mechanism connected with the arc lamp would become deranged by a fine red dust which prevails during the dry season, and which sifts into everything, causing in the case of arc lamps a great deal of trouble to keep the gear clean and in working order.

(To be continued.)

THE CO-EFFICIENT OF ADMIXTURE OF MACERATION WATER.

By Noël Deerr.

In the control of the various schemes devised for extracting sugar from the cane by means of the addition of water and known as maceration, imbibition or saturation, the most important factor is the determination of the degree of admixture of the added water with the residual juice in the megass.

In the *International Sugar Journal*, No. 16, in a paper due to Prinsen Geerligs and E. Rose the degree of admixture of maceration water is defined as

$$\text{sucrose in last mill juice} \times \frac{100\text{—fibre in bagasse}}{\text{sucrose in bagasse}}$$

The quantity 100—fibre in bagasse is of course the quantity of juice in the bagasse expressed percentually, so that the expression $\frac{\text{sucrose in bagasse}}{100\text{—fibre in bagasse}}$ is the percentage of sugar in the residual juice in the bagasse; the degree or co-efficient of admixture of maceration water may then be expressed as $\frac{\text{sucrose in last mill juice}}{\text{sucrose in residual juice in bagasse.}}$

Without wishing to appear to criticise the work of the man who has done more than any other to place the cane sugar industry on a scientific basis, the writer cannot help thinking that this method of expression is liable to serious misinterpretation, which may best be exemplified by an exaggerated example. Let the residual juice in the megass contain 15% sugar, and the last mill juice 12% sugar, and let the last mill juice be diluted by the direct addition of water, without contact with the megass; the admixture in this case is evidently zero, but yet by the Geerligs and Rose formula is $\frac{100 \times 12}{15} = 80.$

As an alternative formula more nearly expressing the efficiency of added water, the writer would propose the following.

Let a = sucrose % of normal mill juice, b = sucrose % of residual juice in megass, c = sucrose % of last mill juice. Then the co-efficient of admixture of the added water is $\frac{a-b}{a-c}$; if b and c are the same, as will be the case with perfect admixture, the expression is equal to unity, but if $a = b$ which will be the case when there is no admixture the expression is equal to zero.*

As an actual example let the normal mill juice contain 15% sucrose, the residual juice in megass 12% sucrose, and the last mill juice 9%

*This argument supposes that the normal juice obtained by the final dry crushings is of the same composition as that obtained by earlier ones; the error introduced is small and unavoidable.

sucrose; then by the formula proposed above the co-efficient of admixture is $\frac{15-12}{15-9}=\cdot 50$; by the Geerligs and Rose method of calculation it is $100 \times \frac{9}{12}=75$.

The divergence between the two formulae becomes greater as the admixture becomes worse or when small quantities of maceration water are used, in which case the Geerligs and Rose formula must of necessity show a high co-efficient of admixture.

Two other methods of expression suggest themselves, both of which require, however, a knowledge of the composition of the megass before the addition of water. Let x be the least quantity of water which would with perfect admixture dilute the residual juice in the megass to the composition of the last mill juice, and let y be the quantity of water actually used; then the efficiency of the added water may be expressed as $\frac{y}{x}$ As an example, from 100 tons of cane let there be obtained 23·81 tons megass containing 42% fibre and 58% juice and let the normal juice contain 15% sucrose. Let the last mill juice, after the addition of 10 tons of added water contain 7% sucrose. To dilute the residual juice in the megass from a normal sucrose content of 15% to a content of 7% are required with perfect admixture 15·78 tons of added water and as only 10 tons were used the efficiency of the added water is $\frac{10}{15\cdot 78}=\cdot 633$.

The second method of expressing the efficiency of the added water and perhaps the most rational method is as follows:

Let x = the amount of sugar actually contained in the last mill juice and y the amount which would have been contained if there had been perfect admixture: then the efficiency of the added water is $\frac{x}{y}$ The calculation under this formula is very simple, for so long as the fibre content of the finally crushed megass is the same, the amount of juice expressed is the same and the quantities x and y are proportional to the sucrose per cent. of the last mill juice actually obtained, and what would be the sucrose per cent. with perfect admixture: taking, for an example, the figures already quoted, with perfect admixture the sucrose per cent. in the last mill juice would be 8·70%, while it actually was 7%; the efficiency of the added water then on these lines would be $\frac{7}{8\cdot 7}=\cdot 904$.

The first of the Canadian beet sugar factories started work on October 30th last. This was the one owned by the Ontario Sugar Co. It cost about $600,000 to erect, and its capacity is 600 tons of beets per diem. 6,000 acres round about are under beet cultivation and a crop of about 55,000 tons of beets is looked forward to.

ON THE ESTIMATION OF RAFFINOSE.

In the *Vereinszeitschrift*, Vol. 52, page 113, G. Reinhardt has pointed out that the employment of extracted animal char for the clarification of products containing much raffinose, in factories employing the strontia process leads to errors in the estimation of saccharose and raffinose. Reinhardt has further shown that a solution of pure inverted saccharose on treatment with prepared char undergoes no alteration in its polariscope rotation, whereas with inverted raffinose in solution with more than 2·5% refined sugar an increase in levo-rotation is noticed.

The writer believes the increase in levo-rotation to be traceable to a specially strong absorption of dextro-rotatory melibiose by means of clear char. In fact, experiments with this object, which he has undertaken in the laboratory of the Desseuer sugar refinery, have confirmed this conjecture. The results are submitted below.

In the first place, I may make the following general remarks in regard to the method of procedure :—

While experimenting with dextrose, levulose and galactose, it was proved necessary to allow the solutions treated with clear char to stand at least five minutes, as only after that period could the absorption be full and constant. It was analogous to the boneblack extracted with HCl from the *Vereins* laboratory.

As experience has shown that, in the clarification of the darkest sugar solutions, 3 gr. of char suffice for half the "normal weight," this quantity was therefore employed in all the experiments, and 40 c.cm. of the 100 c.cm. solutions were clarified with 1·2 gr. (corresponding to 3 gr. per 100 c.cm.), so that this solution could be polarised with or without the addition of char. Further, similar polarisations were undertaken at a temperature of 20° C. in the surrounding pipe.

1. The following experiments were undertaken in order to demonstrate on the one hand the unchangeableness of inverted saccharose and, on the other, the increase in levo-rotation of strongly raffinose-tainted saccharose due to the employment of char.

a. 13·024 gr. of saccharose (best refined), equal to half the "normal weight," were, as is customary, inverted in a 100 c.cm. flask, with 5 c.cm. HCl of 1·19 Sp. Gr., and after cooling filled up to the mark.

Rotation without char .. — 16·3°
,, with ,, .. — 16·3°
Calculated at .. .. .. — 16·3° with 100% solution.

b. A mixture of 5·861 gr. saccharose (45% the "semi-normal weight") and 1·917 gr. raffinose (12% of the "semi-normal weight"), as is met with in exhausted molasses in strontia-

process factories, was inverted in the usual way. (It is borne in mind that the raffinose contains no more than 81·55% refined sugar.)

Rotation without char .. .. — 1·4°
,, with ,, ... — 2·4°
Polarisation of original solution .. .. .. + 33·7°

Calculated according to the Herzfeld formula, we have:—

Without char.. .. 44·77% saccharose; 12·3% raffinose.
With ,, ... 46·8% ,, 11·1% ,,

Thus by the addition of char, 2·1% too much saccharose and 1·2% too little raffinose is the result.

2. Saccharose divides under inversion with the addition of a molecule of water into equal parts of dextro-rotatory dextrose, and levo-rotatory levulose, *i.e.*, 13·024 gr. of saccharose yield 6·855 gr. of levulose. To account for the unchangeableness of inverted saccharose on the addition of char, there are only two possible solutions; either, neither the dextrose nor levulose are absorbed, or else both, in such a way that their actions—positive and negative—neutralize one another.

In order to establish this point:—

a. 6·855 gr. dextrose were dissolved with hot water in a 100 c.cm. flask, mixed with 5 c.cm. HCl to ensure the same conditions as above, were cooled and then filled up to the mark.

Rotation without char .. + 20·8° (= 99·5 dextrose.)
,, with ,, .. + 18·4°

Thus through the char a considerable amount of dextrose was absorbed.

b. Similarly, 6·855 gr. levulose were made into a 100 c.cm. solution.

Rotation without char .. — 32·7° (= 89·7% levulose).
,, with ,, .. — 32·0°.

Here also levulose is absorbed, though to a smaller extent.

c. From solutions of (*a*) and (*b*) that were not treated with char, 20 c.cm. of levulose and 18 c.cm. of dextrose solution (corresponding to their purity) were mixed.

Rotation without char .. .. — 7·4°.
,, with ,, ... — 7·4°.

Similarly, a mixture of equivalent amounts of levulose and dextrose solution, which had been separately treated with char, gave a rotation of — 7°.

These results show that the addition of clear char to inverted saccharose solution causes no alteration in the rotation, because owing to the absorption of dextrose and levulose, any faults are neutralised.

3. Raffinose ($C_{18}H_{32}O_{16}$) divides by inversion (as above stated) with the addition of a molecule of water into one-third levo-rotatory levulose ($C_6H_{12}O_6$), and two-thirds dextro-rotatory melibiose ($C_{12}H_{22}O_{11}$), which latter, by the employment of concentrated acids,

with the addition of another molecule of water, is split into equal parts of dextrose and galactose.

Now, since, as shown above, levulose is absorbed on the addition of char, even though in a small degree, it follows that this must be the case with melibiose in still greater proportion, because the inverted raffinose after treatment with char shows an increase in levo-rotation as well as a diminution in dextro-rotation. In fact, the following tests proved the accuracy of this supposition.

a. 1·596 gr. of melibiose (of Th. Schuchardt-Gorlitz) were dissolved in hot water in a 100 c.cm. flask, mixed with 5 c.cm. HCl, allowed to cool, and then filled up to 100 c.cm.

Rotation without char .. + 8·8° (= 75·87% melibiose).
,, with ,, .. + 6·8°.

Melibiose is thus strongly absorbed by clear char.

b. 5·681 gr. saccharose (=45% the "semi-normal weight.")
+1·398 gr. melibiose } (=12% raffinose of the "semi-normal
+0·558 gr. levulose } weight.")

Such a mixture, as occurs in exhausted molasses, was inverted in the usual manner and filled up to 100 c.cm. (The mixture of the melibiose and levulose were calculated according to their purity.)

Rotation without char .. .. — 2·4°.
,, with ,, ... — 3·5°.

Thus, by adding char to a solution of inverted raffinose, such a strong absorption of dextro-rotatory melibiose results that the levo-rotation is increased.

For laboratory practice in factories employing the strontia process, where products with 0 to 15% of raffinose are tested, it is necessary in the interests of accurate analysis to establish the degree of absorption by char.

Now, I have inverted such mixtures of saccharose and raffinose, and treated them with char, as is done in strontia factories to after-product sugar and exhausted molasses, which contain, besides 44-85% saccharose, 1 to 14% raffinose, and arrived at the following results:—

1. The degree of absorption is entirely independent of the quantity of the given saccharose, and is only effected by the quantity of raffinose.

2. When employing half the "normal weight" in inversion, and when clarifying with 3 gr. of char, an increase of the levo-rotation is shown first with a proportion of

3% raffinose by.. .. .. 0·1°
4% ,, ,, ... 0·2°
5% ,, ,, ... 0·3° and so on.
14% ,, ,, ... 1·2°

These facts were determined by experiments with mixtures which, besides varying amounts of saccharose, contained 1, 3, 5, 7, 12, and 14% of raffinose.

From these observations we may allow the following corrections for the accurate estimation of raffinose and saccharose in dark-coloured solutions. When employing half the "normal weight," and when clarifying with 3 gr. char, we must subtract on inversion from the figures of levo-rotation :—

With a proportion of about	3%	raffinose	..	0·1°
,, ,,	4%	,,	...	0·2°
,, ,,	5%	,,	..	0·3° and so on.
,, ,,	14%	,,	....	1·2°

(Wiske in *Vereinszeitschrift.*)

SUGAR IN QUEENSLAND.

The sugar crop of 1901 was an improvement on the previous year, but did not come up to the returns of 1898. The figures for the four years are :—1898, 82,391 acres crushed, average yield of sugar per acre, 1·99; 1899, 79,435, 1·55; 1900, 72,651, 1·28; 1901, 73,160, 1·55. The total weight of cane crushed in 1901 was 1,180,091 tons, or an average of 15·10 tons to the acre. The weight of cane required to make a ton of sugar was 9·76 tons. The number of factories in connection with the industry were :—Refineries, 2; sugar manufactories, 52; crushing mills only, 6; total, 60. The total weight of sugar was 120,858 tons. The quantity exported was 81,024 tons for the sugar year, which ended on May 31st, 1902, and the estimated requirements for Queensland were 28,270 tons. The surplus of the operations of last season was 11,564 tons. The sugar content of the canes was not so high as in 1900, and it took on an average 0·59 ton more cane to make a ton of sugar. This was caused in the central and northern districts by the lateness of the rains, which did not fall until February; the cane did not make growth, and was immature; in addition to which it was affected by frost, and its density consequently lowered. The southern district produced a ton of sugar from 10·43 tons of cane, as compared with 10·77 tons in 1900. It was estimated that the annual consumption of sugar in the Commonwealth amounted to 176,031 tons, so that with a return of normal seasons, and the benefits of interstate free-trade, there should be sufficient inducement for the extension of the area under sugar-cane, in order to obtain command of the sugar market in the Commonwealth. The prospects for the 1902 season are particularly good in the north, but the central and south will show a considerable shortage, owing to the continuance of the drought. The output for the whole State may be less than in 1901.—(*North Queensland Herald.*)

CONSULAR REPORTS.

SWEDEN.

Gothenburg.—The summer, as is well known, was distinguished by a severe drought and caused much apprehension for the beetroot culture. The drought in Scania, however, was not nearly so severe as up the country, particularly in the vicinity of Lake Mälaren, and furthermore the beets are well able to endure dry weather, the result having turned out particularly good.

The quantity was very large and the percentage of sugar, as might be expected, exceedingly high. At the opening of the season the prospects of many of the factories appeared bad for want of an adequate supply of water for the works, but even this turned out better than was anticipated. Stoppages occurred at different places on account of the drought, but these were not of so long a duration as to cause any actual harm. Neither did the very changeable weather occasion any damage to the beets, and there is consequently every reason to look upon the result of this industry as particularly favourable.

A new factory at Skifarp has commenced work during the autumn.

Of the activity at the refineries there is not much to be said. They obtained their necessary supply of raw sugar, so that no import worthy of note has taken place.

Imports of sugar during the years 1900-1901 :—

	1901. Tons.	1900. Tons.
Gothenburg	127	1,717
Malmö	21	3,199
Ystad	4	3,113

JAPAN.

Nagasaki.—The import of sugar during 1901 shows an increase of 33,523 cwts. in quantity and £29,610 in value, as compared with the preceding year, which may be said to be attributable to the action of the Japanese Government in imposing a tax on sugar called the Consumption Tax. This tax is levied on all sugar which goes into consumption in the country and is collected as regards imported refined sugars before they are removed from the custom house, and as regards sugars refined in Japan, when delivered from the refineries. This tax, although declared to be an excise duty, appears, as far as the foreign importer is concerned, to largely resemble a second import duty. Owing to the method of collection, the importer has, not only to bear the charge for interest on the amount of the Consumption Tax from the date of arrival of his sugar in Japan until such time as it goes into consumption, but he has also to run the risk of paying a

greater amount of tax than would be leviable on its going into consumption, supposing that from long storage it had deteriorated in quality or lost in weight. In order to make the latter point clear, the following information in regard to the classifications of the different kinds of sugars under the Customs Tariff and under the Consumption Tax is appended:—

Classification under the Customs Tariff.

Class I.—Raw sugar or sugar partially refined up to and inclusive of No. 14 Dutch colour standard.

Note.—This class includes blacks, browns, reds and dark yellows.

Class II. Refined sugar Nos. 15 to 20 Dutch colour standard.

Note.—This class embraces light yellows.

Class III.—Refined sugars above No. 20 Dutch colour standard.

Note—This class includes all whites.

Classification under the Consumption Tax.

Class I.—Up to No. 3 Dutch standard of colour and under.

Class II.—Above No. 3 Dutch standard of colour and below No. 15.

Class III.—Nos. 15 to 20 Dutch standard of colour inclusive.

Class IV.—Above No. 20 Dutch standard of colour.

Consumption Tax, per picul (133 lbs.), on Class I., 1 yen.
,, ,, ,, ,, on Class II., 1 yen 60 sen.
,, ,, ,, ,, on Class III., 2 yen 20 sen.
,, ,, ,, ,, on Class IV., 2 yen 80 sen.

From the foregoing it will be seen that it is possible that a foreign importer may have paid Consumption Tax on a shipment of sugar classed on arrival as No. II., which, on delivery for consumption, may, owing to long storage, have deteriorated into Class I.; a loss of 60 sen per picul being sustained thereby. It was considered probable that this tax would be levied from April 1st, 1901, and moderate speculative purchases from Hong-Kong, China, Java and Manila were made by dealers, with the object of anticipating the import. Owing, however, to disagreement between the Upper and Lower Houses of the Diet, the tax did not become operative until October 1st, and, time allowing for purchases from Europe, heavy speculation ensued, resulting in serious hampering of the trade. Owing to the flooding of the market with unsaleable stocks in anticipation of the new tax, the usual difficulties arose with Japanese purchasers. Having anticipated large profits the dealers have shown themselves unwilling to accept the losses that have resulted from their speculations, and have asked for time and accommodation, free storage and reductions in contract price, all of which have had to be acceded to by the foreign importer.

The competition of the native refineries is becoming keener, not only in Japan, but also in Corea, and there is no reason why, as they

are able in course of time to increase their plant, they should not gradually absorb the entire trade of Japan.

Shimonoseki.—The chief article of import with which foreign merchants have to do is sugar.

The import in 1901 was nearly double that of the preceding year, the exact figures being:—

Year.	Quantity. Tons.		Value. £
1900	21,511	..	304,549
1901	11,397	..	167,251
Increase, 1901	10,114	..	137,298

This is to be accounted for by the fact that a new inland revenue tax was imposed on all sugar not cleared from the customs by October 1st. Importers expected that this new tax of over 20 Dutch standard, 5s. 7d. per picul (133⅓ lbs.); over 15 to 20 Dutch standard, 4s. 4d. per picul (133⅓ lbs.); under 15 Dutch standard, 3s. 2d. per picul (133⅓ lbs.) would result in a considerable advance in price, which expectation has unfortunately not been realised, so that now they have to clear their heavy and deteriorating stocks at about 2s. per picul under prices paid, in addition to meeting their accumulating charges.

The bulk of the import is of qualities above 20 Dutch standard; below 15 import has practically ceased, the tendency being towards better grades.

"A" quality represents 15 to 20, and "B" quality above 20 Dutch standard.

Of the total import more than 15,000 tons valued at £304,550, was of "B" quality, while some 2,695 tons of beet sugar, valued at £31,764, came from Austria-Hungary, and 1,760 tons, worth £21,549, from Germany. The principal objection to beet sugar is its lack of sweetening properties, though, apart from its cheapness it has the advantage of being quick in drying with some forms of cake manufacture. It is also stated to be inferior in keeping qualities to cane sugar.

China.

The Hong-Kong refineries supply nearly the whole of the imported sugar but during the last few months beet sugar has entered the field, and determined efforts are being made to push the sale thereof. The consumption of beet sugar in India, where it first appeared in 1893, has made rapid strides, and it remains to be seen how the Chinese will take to it. One is inclined to think that it would not be adapted to Chinese use, and the fact that it deteriorates, if kept in stock for any length of time, is certain to militate against it.

The export of sugar is confined to the southern ports of Canton, Swatow, and the Island of Hainan, whence it is exported to Hong-Kong, and from there reshipped to China, where, in its assumed capacity of a foreign import, it can claim transit pass privileges.

Nanking.—Refined sugar from Hong-Kong increased in quantity from 23,391 cwts. in 1900 to 43,525 cwts. in 1901. The sale, which is in the hands of a British firm, is improving rapidly, and has greatly benefited by the opening of the port.

Philippine Islands.

The export of sugar fell from 60,966 tons in 1900 to 54,334 tons in 1901. In 1893 256,034 tons were exported. War and rinderpest have both contributed to this result, but poor prices and competition in the Chinese market have had their effect.

Chili.

The value of imports of sugar into Chili during 1901 was $4,014,384 for brown sugar, and $847,633 for refined.

Dutch Guiana.

The exports of sugar during 1901 were as follows:—

				£
Molasses, vacuum pan	gals.	594	..	10
Rum	,,	216,832	..	13,963
Moscovado	tons	179	..	1,499
Vacuum pan, 1st	,,	9,198	..	91,900
,, ,, 2nd	,,	701	..	5,263

Of these the following were shipped to England:—

	Tons.		£
Vacuum pan, 1st	346	..	3,469
,, ,, 2nd	104	..	782

In addition to this, sugar products, valued at £25,847, were sent to Demerara, for transhipment to the United States of America, &c.

About 6,840 tons of vacuum pan sugar, valued at £68,123, were shipped direct to the United States.

The sugar crop was on the whole satisfactory, and though the yield was somewhat below that of the previous years, it was considerably above the average for the last six or seven years.

The official returns for the last four years are:—

Articles.	Quantity. 1898.	1899.	1900.	1901.
Muscovado ...tons.	354	250	187	201
Vacuum pan . ,,	11,815	9,316	12,863	12,520
Molasses.....gals.	339,988	270,820	389,466	345,840
Rum .... ,,	232,672	185,834	280,500	263,450

There are sixty-eight sugar companies in the Hawaiian Islands, of which sixty own their sugar houses and manufacture their cane. These are distributed as follows: Twenty-nine on Hawaii, twelve on Maui, nine on Oahu, and eighteen on Kauai. The sugar produced last year was as follows: Hawaii, 115,224 tons; Maui, 57,347 tons; Oahu, 53,625 tons; Kauai, 63,348 tons; or a total of 289,544 tons.

PUBLICATIONS RECEIVED.

Zabel's Jahr-und Adressbuch der Zuckerfabrikfn Europa's für die Campagne, 1902-03. Published by the "Centralblatt für die Zuckerindustrie," Madgeburg. 33rd year of issue. To be had from the "Verlagsanstalt für Zuckerindustrie," Madgeburg, Germany. Price, 4mk.

Cattle Feeding with Sugar Beets, Sugar, Molasses, and Sugar Beet Residuum. By Lewis S. Ware. Philadelphia Book Co., 15, So. Ninth Street; 389 pp. 8vo; $2·50 net, post free.

The editor of the *Sugar Beet*, residing as he does chiefly in the centre of the European beet sugar system, has no doubt exceptional opportunities for accumulating information on matters more or less appertaining to the cultivation of the sugar beet. Several works have appeared from time to time from his pen, and the latest is an unusually large volume on "Cattle Feeding." He realises that those of his countrymen engaged in beet growing will have to adopt certain principles of economy if they desire to continue their industry much longer as a profitable undertaking. It is obvious that when the residuum of a manufacturing process is turned independently to account, the profits on the whole scheme are more or less considerably enhanced: nay, in some cases the cost of the primary article is reduced in consequence. Thus, for example, the low price of gas is governed by the fact that the chief residuum in its production (coke) commands a profitable market price. Now, in beet sugar manufacture, the residuum mainly consists of beet pulp or *cossettes* (to use the word that seems to have been adopted by now to designate the beet slices or chips) and molasses, and these have a nutritive value when used in proper proportion as cattle food. The question of winter fodders always weighs heavily with cattle farmers, and often it is a point whether it were not better to sell the steers at approach of winter. The special advantages of the beet lie in the fact that the farmer who grows it can first sell it for its sugar content, and then, subsequently, get it back in the form of pulp for cattle feeding. This plan is claimed to overcome the difficulty of expensive fodder; it is carried out with success in France and Germany. But it must not be supposed that this book is written solely for the purpose of treating on the growth of beets for cattle feeding. That, it is true, is the main theme, but there is yet a great deal of useful information to be gleaned as to the nutritive values of other foods. The subject of cattle feeding is treated from a scientific and physiological standpoint: the essentials for fattening, the effect of the different foods on an animal's growth,

the food requirements for steers, for milch cows, for sheep, &c., are all discussed. The proper and improper use of beets as food is described in detail, comparative analyses of different foods are given, and descriptions and drawings of pulp machines have a chapter devoted to them. Altogether it is an interesting and instructive book, and there is hardly a dull page from beginning to end. We think, however, that its somewhat high price may affect its otherwise ready sale, at least in those quarters where long adverse conditions in the sugar industry have resulted in a more or less impoverished husbandry.

Correspondence.

Mr. NORMAN LAMONT ON THE WEST INDIES.

To the Editor of "The International Sugar Journal."

Sir,—There is a point in Mr. Norman Lamont's article on the sugar industry of the West Indies* which calls for some comment. The writer refers to the generous application of fertilisers to the soils of Hawaiian plantations, and implies that Hawaii is a model which the West Indies would do well to copy.

The belief that the sugar industry of the Hawaiian Islands is conducted in the most up-to-date and scientific manner has become so widespread that we have actually come to believe it ourselves. As a matter of fact, the natural conditions, soil and climate, are so absolutely perfect that it would be a disgrace to us if we obtained poorer results. The magnificent yields which some of our estates afford are due to those conditions, and not to any particularly scientific methods of cultivation or manufacture. As might be expected of flourishing corporations, we have the latest and most improved implements and machinery, but Mr. Lamont's strictures on the management of the West Indian machinery apply exactly to Hawaii. Every large plantation has a chemist who is retained as a sort of understudy to the sugar-boiler, makes a large number of polarisations every day, and, finally, at the end of the season, makes a statement of the losses which have occurred in the mill. The losses in the field are evidently of no importance, for no effort whatever is made to trace them. But he is not allowed (except in two or three cases) to interfere in the management of the boiler-house. This duty is performed by the sugar-boiler, a generally handy man, who, although he has had no technical training, and would not attempt to even define the sciences proposed by Mr. Lamont as the curriculum of a tropical university, knows a little of almost everything. And if the

*See *Int. Sugar Journal*, Vol. IV., p. 522.

chemist is made little use of in the factory, he is (with few exceptions) entirely dispensed with in the field.

Mr. Lamont's remarks on fertilising in the West Indies are also applicable to Hawaii, and the incessant forcing of the cane with large quantities of nitrate of soda which obtains here, is surely not a procedure he would recommend for adoption in the West Indies. The great returns from Hawaiian plantations which are so much talked of are obtained on estates on the leeward side of the islands, where the rainfall is from 40 to 100 inches per annum, and soluble fertilisers applied to the soil are not washed away by heavy rains, where strong winds are absent, and the cane can be given just as much or as little water as desired. On the windward side of the islands, where the climatic conditions are quite different, and the soils more or less denuded by excessive rains and in less favourable mechanical condition, we have a very different state of affairs. On such plantations, 14 tons of sugar per acre is a dream whose realisation is as much longed for, but as unattainable, as it is in the West Indies. In this connection I may say that a ton in Hawaii means 2,000 lbs., and that the fields are only cropped once in two years.

These facts go to prove that the "scientific methods" of Hawaii are somewhat of a myth. Such methods are very much required here, but, strange to relate, in proportion as an estate becomes poorer, and the dividends smaller, the management reduces the skilled staff or replaces it with cheap labour. Such a proceeding argues but little faith in our vaunted "science," but is in reality quite defensible when the profit from expensive help is doubtful. On the other hand, the chemist, for example, is given few opportunities to show that he is a profitable investment. To use the words of the Demerara planter who takes exception to Mr. Lamont's article, the chemists "have much to say about both control and manufacture." This amusing argument (which confirms rather than refutes Mr. Lamont's contention) succinctly defines the present position of the chemist. He has, indeed, very much to say, but he is better to save his "wind" and not say it, for his opinion, although often given a hearing, is seldom acted upon, especially if it happens to conflict with that of the sugar-boiler.

Yours truly,

HAWAIIAN.

Honolulu, Hawaii,
November 22nd, 1902.

The *D.Z.I.* mentions a method of cleaning sand filters. It consists in introducing a central hollow axis with perforated arm attachments. Water is circulated through this axis and, on escaping through holes in the arms, raises the sand to the upper surface, where all the impurities are eventually found deposited.

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. Thompson, C.E., F.C.S., M.I.M.E., Chartered Patent Agent, 6, Lord Street, Liverpool ; and 322, High Holborn, London.

ENGLISH.—APPLICATIONS.

22537. C. B. Duryea, London. *Process of producing maltose syrups and sugars.* 16th October, 1902. Complete specification.

23779. J. McGlashan, Glasgow. *Improvements in the manufacture of sugar.* 31st October, 1902. Complete specification.

24768. J. C. F. Lafeuille, London. *An improved process and apparatus for extracting sugar from beet and the like.* 11th November, 1902.

24871. A. Mertens, London, *Improvements in the process of making syrup from beet and like roots and of refining sugar containing liquids.* 12th November, 1902.

26364. G. W. Barratt, F. Barratt, A. Barratt and J. B. Stennett, London. *Improvements in and relating to means for rolling boils or masses of boiled sugar in the manufacture of sweets.* 29th November, 1902.

26570. H. Winter, London. *Improvements in and relating to the treatment of sugar juice.* 3nd December, 1902.

ABRIDGMENTS.

15031. J. Czapikowski, Nymburg, Bohemia. *Improvements in means for boiling sugar.* 5th July, 1902. This invention has for its object improved means for boiling sugar juices and the like, which consists of a rotary mixer which is formed and constructed to impart heat to the sugar juices or the like by circulating hot or superheated steam through said mixer, said rotary mixer also serving to cool the boiled juices by circulating water through the mixer.

21985. F. Hlavati, Antwerp, Belgium. *Improvements in the process of extracting sugar from beetroot and sugar cane juices and other fluids containing sugar.* 31st October, 1901. This invention has reference to improvements in the process of extracting sugar from beetroot and sugar cane juices and other fluids containing sugar in solution, and the object of the invention is to enable the whole of the sugar to be extracted. "It consists in the use of hydrofluosilicic or hydrofluoboric acid previously neutralized by calcium hydroxide, added to the sugar juice during its customary treatment with milk of lime, and the treatment of the sugar juice with oxidising agents—for example, calcium peroxide, manganese peroxide, hydrogen peroxide.

GERMAN.—ABRIDGMENTS.

132479. INDIA DEVELOPMENT LIMITED, of London. *A settling vessel for sugar juice or other liquids.* 10th August, 1901. In this settling vessel the liquid to be clarified is introduced very quietly and uniformly, and the clarified juice is also drawn off perfectly quietly and uniformly without local currents in the liquid and without the liquid during the settling being unnecessarily exposed to the action of the surrounding air. In an ordinary cylindrical settling vessel with funnel shaped bottom, a partition shaped to correspond to the cylindrical walls is inserted, the under edge of which partition forms an annular dividing slot or aperture for allowing the liquid to be clarified to flow in from an outer chamber which remains between it and the wall of the vessel. The upper edge of the partition is provided with a horizontal flange, over which the clarified liquid runs away uniformly and quietly into a gutter surrounding on all sides the upper edge. The unpurified liquid flows preferably out of a channel arranged round the edge of the vessel, and having a perforated bottom, into the outer chamber between the partition and the wall of the vessel. A stirring or agitating device, the lower arms of which are formed to correspond with the tapering shape of the bottom of the vessel, keeps the latter and the discharge slot, free from sludge.

132514. HENDRIK COENRAD PRINSEN GEERLIGS, Pekalongan, Java, and KAREL RUDOLF HAMAKERS, Semarang, Java. *An apparatus for progressive extraction of solid substances, more particularly the pressed residues of the sugar manufacture.* 6th March, 1901. In this apparatus the liquid moves in counter current to the substances to be extracted, which are alternately drawn on a conveyer belt through a number of successive pressing rollers and through the liquid. In doing this, the improved peculiar arrangement of the pressing rollers allows of the substances being drawn in a uniform course directly through the pressing rollers, and the liquid moving in a counter current, as the pressing rollers lie within the extracting trough in such a way that they form at least partial partitions serving for dividing the separate compartments of the trough.

IMPORTS AND EXPORTS OF SUGAR (UNITED KINGDOM),

To end of November, 1901 and 1902.

IMPORTS.

Raw Sugars.	Quantities. 1901. Cwts.	Quantities. 1902. Cwts.	Values. 1901. £	Values. 1902. £
Germany	3,697,774	6,020,178	1,638,614	2,098,214
Holland	271,061	313,902	113,150	101,471
Belgium	1,389,261	563,278	622,814	200,014
France	3,337,947	1,702,168	1,678,721	656,674
Austria-Hungary	76,521	121,206	31,707	42,478
Java	173,134	....	73,287	....
Philippine Islands	50,290	5,430	22,705	1,680
Peru	61,987	126,814	28,029	44,206
Brazil	338,058	565,507	153,923	186,518
Argentine Republic	578,942	623,371	273,298	229,629
Mauritius	414,296	323,948	195,130	111,398
British East Indies	168,432	182,979	75,102	67,375
Br. W. Indies, Guiana, &c.	902,229	1,231,098	666,209	726,448
Other Countries	201,983	151,550	95,594	58,674
Total Raw Sugars	11,661,915	11,931,429	5,668,283	4,524,779
Refined Sugars.				
Germany	11,276,948	12,404,397	6,912,567	6,432,321
Holland	2,281,384	2,194,408	1,487,867	1,258,785
Belgium	410,087	142,972	255,496	82,541
France	4,539,120	2,205,483	2,753,201	1,157,219
Other Countries	13,699	32,752	10,297	15,013
Total Refined Sugars	18,521,238	16,980,012	11,419,428	8,945,879
Molasses	1,573,111	1,252,831	340,027	242,497
Total Imports	31,756,264	30,164,272	17,427,738	13,713,155

EXPORTS.

British Refined Sugars.	Cwts.	Cwts.	£	£
Sweden and Norway	36,745	39,351	25,684	21,391
Denmark	93,000	122,934	58,223	62,210
Holland	48,546	66,011	28,473	34,510
Belgium	8,318	9,343	5,042	4,648
Portugal, Azores, &c.	22,761	7,712	13,184	3,863
Italy	4,034	22,664	2,356	10,669
Other Countries	294,455	394,969	190,647	233,170
	507,859	662,984	323,609	370,461
Foreign & Colonial Sugars.				
Refined and Candy	68,358	42,588	47,838	27,202
Unrefined	112,438	84,818	69,395	41,779
Molasses	50,017	2,528	15,920	996
Total Exports	738,672	792,918	456,762	440,438

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1902. Tons.		1901. Tons.
Total Receipts, 1st Jan. to Nov. 13th ..	1,746,319	..	1,721,074
Receipts of Refined ,, ,, ,, ..	18,778	..	38,545
Deliveries ,, ,, ,, ..	1,768,452	..	1,688,273
Consumption (4 Ports, Exports deducted) since 1st January	1,717,611	..	1,642,963
Importers' Stocks (4 Ports) Dec. 17th ..	3,178	..	32,801
Total Stocks, Dec. 17th	154,000	..	134,208
Stocks in Cuba, ,, ,, ...	52,000	..	22,498
	1901.		1900.
Total Consumption for twelve months ..	2,372,316	..	2,219,847

CUBA.

Statement of Exports and Stocks of Sugar, 1901 and 1902.

(Tons of 2,240lbs.)	1901. Tons.		1902. Tons.
Exports	560,700	..	761,077
Stocks	37,079	..	68,727
	597,779	..	829,804
Local Consumption (12 months)..	38,600	..	40,250
	636,379		870,054
Stock on 1st January (old crop)	523	..	19,873
Receipts at Ports up to 31st November ..	635,856	..	850,181

Joaquin Guma.

Havana, 30th November, 1902.

UNITED KINGDOM.

Statement of Eleven Months' Imports, Exports, and Consumption for Three Years.

From *Produce Markets' Review.*

	1902. Tons.	1901. Tons.	1900. Tons.
Stock	114,894 ..	65,549 ..	57,815
Imports, Raw Sugar, Jan. 1st to Nov. 30th	596,571 ..	583,096 ..	596,207
,, Refined, Jan. 1st to Nov. 30th ..	849,001 ..	926,062 ..	840,858
,, Molasses, Jan. 1st to Nov. 30th..	62,641 ..	78,655 ..	64,082
	1,623,107	1,653,362	1,558,962
Stock, in 4 chief Ports	111,295 ..	79,162 ..	49,943
	1,511,812	1,574,200	1,509,019
Exports (Foreign, and British Refined) ..	39,519 ..	34,433 ..	48,664
Apparent Consumption for Eleven months.	1,472,293	1,539,767	1,460,355

STOCKS OF SUGAR IN EUROPE AT UNEVEN DATES, DECEMBER 1ST TO 17TH, COMPARED WITH PREVIOUS YEARS.

IN THOUSANDS OF TONS, TO THE NEAREST THOUSAND.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	TOTAL 1902.
122	738	743	614	259	3008

	1901.	1900.	1899.	1898.
Totals	2821 ..	2319 ..	2203 ..	2184

TWELVE MONTHS' CONSUMPTION OF SUGAR IN EUROPE FOR THREE YEARS, ENDING NOVEMBER 30TH, IN THOUSANDS OF TONS.

Great Britain.	Germany.	France.	Austria.	Holland, Belgium, &c.	Total 1902-03.	Total 1901-02.	Total. 1900-01.
1793	795	611	387	524	4110	4117	4110

ESTIMATED CROP OF BEETROOT SUGAR ON THE CONTINENT OF EUROPE FOR THE CURRENT CAMPAIGN, COMPARED WITH THE ACTUAL CROP OF THE THREE PREVIOUS CAMPAIGNS.

(From Licht's Monthly Circular.)

	1902-1903. Tons.	1901-1902. Tons.	1900-1901. Tons.	1899-1900. Tons.
Germany	1,730,000 ..	2,299,408 ..	1,984,186 ..	1,798,631
Austria	1,050,000 ..	1,302,038 ..	1,094,043 ..	1,108,007
France	900,000 ..	1,183,420 ..	1,170,332 ..	977,850
Russia	1,225,000 ..	1,110,000 ..	918,838 ..	905,737
Belgium	240,000 ..	350,000 ..	393,119 ..	302,865
Holland	120,000 ..	203,172 ..	178,081 ..	171,029
Other Countries .	355,000 ..	400,000 ..	367,919 ..	253,929
	5,620,000	6,843,038	6,046,518	5,518,048

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☞ The Editor is not responsible for statements or opinions contained in articles which are signed, or the source of which is named.

Ratification of Brussels Convention.

Up to the time of going to press, we have been unable to obtain definite information that the ratification of the Brussels Convention has been officially transmitted to Brussels by all the Powers concerned. But the news to hand so far has not revealed any hitch in any of the parliamentary proceedings of the respective States, so that there is no reason for supposing that the ratification will not follow. Germany's ratification reached Brussels on the 15th January, and that of France on the 29th of January. The French Bill by the way was passed in the Senate, on January 24th, by 273 votes against 5. The Austrian Bill did not come up in Parliament till the last week in January, and then met with so much opposition, that at one time it looked as if it might be wrecked; but fortunately the Austrian Government succeeded in carrying it through the Lower House on January 30th and through the Upper House on the following day. Great Britain, Holland, and Hungary have all passed their parliamentary proceedings, but so far no news has come to hand of their having officially announced their decision to the Brussels Committee.

We may therefore consider the ratification of the Brussels Convention on the part of the Powers concerned in it to be an established fact, and one of the most momentous questions that ever affected the sugar industry to be settled, as we hope, for ever. There will be few quarters outside the ranks of the German and Austrian sugar manufacturers, where this result will not be received with a sigh of relief. A new era is about to dawn for the world's sugar industry; monopolies are about to go, and "a fair field and no favours" will take their place. As far at least as England is concerned, a truer aspect of "free trade" than has hitherto held, will now receive official sanction, and the effects will not be confined to the sugar industry alone, though

the latter will be the first to be benefited. Let us hope then that the British refining industry will make a speedy recovery to its old-time prosperous condition.

Cane Sugar in Germany.

In Germany the new protective duty of 6fr. per 100 kilos., which will come into force under the provisions of the Brussels Convention, is considered inadequate to keep out foreign cane sugar. The present protective duty is four times as great, and yet it is stated a considerable quantity of cane sugar finds its way into that country to be used for the production of sparkling wines. If this is so, then we may expect at a not distant date to see a greater demand for colonial cane sugar in those countries where hitherto the beet has reigned supreme. Moreover, as regards the competition of German beet in foreign markets, the Director of a German refinery lately fixed the cost of 1 cwt. of raw sugar f.o.b. at 8s. 4d., and expressed the opinion that at that figure Continental beet could not compete with cane or American beet. His opinion was that cane, while costing on the one hand 1s. per cwt. less than beet to produce, could also command 1s. per cwt. more "by reason of its superior flavour." But things will have come to a pretty pass if Germany, with all her scientific resources, cannot hold her own in the sugar trade, when she is put on an equal footing with other competitors.

Total Exhaustion of Sugar Cane.

We hear that Mr. H. C. Prinsen Geerligs' new process of "total exhaustion of sugar cane" has proved successful in practice. In the experiments carried out to test it, 800 tons of sugar cane were worked up in 24 hours; the sucrose content of the cane was 15·3%; the analysis of the juice was Brix, 20; Sucrose, 18; Purity, 90. The loss of sucrose in bagasse on 100 cane amounted to 0·16%, whilst the bagasse contained 48% of water and was used as fuel without preliminary drying in the sun. The dilution was only 15%, and the purity of the juice was only a trifling smaller than that of the first mill juice. The figures given show a high standard, and as next year a great Java sugar factory will adopt this process, some interesting results may be expected. We shall look forward to them.

The Sugar Cane in Egypt.

We commence in this number a series of interesting papers by Mr. Walter Tiemann on "The Sugar Cane in Egypt." This writer, whose name has been frequently before our readers as a contributor of articles on the Egyptian sugar industry, recently concluded a five years' engagement in that country, and he has now favoured us with the results of his studies and investigations. We hope to illustrate the articles, and numerous tables and diagrams will be included in them.

Sugar Machinery.

The year 1902 appears to have been one of the worst the British sugar machinery manufacturers have ever encountered, and even the best firms (who make nothing else) have been unable to keep their works fully employed. Orders have been scarce; this is only natural, because the demand for plant is largely governed by the price of sugar prevailing, and the latter has been at the lowest figure ever known, viz., about £6 per ton. It is clear then that the process of abolishing bounties has not come a moment too soon; but as the success of the Brussels Convention seems almost a certainty by now, it may be taken for granted that an increased demand for up-to-date machinery will make itself felt at no distant date, and not merely from the West Indies, but also from S. America, and the East. As a proof of this, we may cite the case of a Demerara estate that desired to lay in new machinery some twelve months ago; the order for the same was, however, not sent out till it was known that the Brussels Conference had proved a success. If the latter had been a failure, it is safe to say the order would never have been placed. We do not know whether it was the same estate that desired to obtain a nine-roller mill and had to get one from America, because no British firm had ever made one and therefore had no patterns in stock. This should not be allowed to occur again. We recently paid a visit to the works of a Glasgow engineering firm whose speciality was sugar machinery, and were much impressed with the splendid plant available for their work; a selection of the best machines of all kinds had been chosen, and though the firm were patriotic enough to prefer their own country's products, they had not scrupled to go to America for a machine if they thought it superior to any home made patterns. Under these circumstances there should be no question about the work turned out being of the very best description and workmanship. And those firms who in later years have spent considerable sums of money in improving their plants, should "in no wise lose their reward" when the demand for new machinery commences anew.

The value of the sugar crop of 1901 in Australia is given by Dr. Maxwell as follows:—

	£
Exported sugars	792,329
Home consumption	276,445
Uncrushed cane	260,000
Cane feed, molasses, and distillery products ..	120,000
	£1,448,774

The above does not include reserve stocks of sugar intended for export.

SIR WILLIAM HARCOURT ON THE BRUSSELS CONVENTION.

Anyone who was present at this debate must have been struck with the very satisfactory thoroughness shown by the Government in mastering the details of a difficult subject. The next impression was a painful one, in seeing leading statesmen on the opposite side making the most reckless use of flagrant mis-statements in order to oppose the measure. The business of an opposition, they say, is to oppose. But it can never be to the interest of those who desire the reputation of leaders in political thought to avail themselves, without enquiry, of any wild assertions that may be flying about, and to give to them the imprimatur of their authority. The speeches of men of high reputation like Sir William Harcourt were based on the "perfectly ludicrous" assertions of the Confectioners' Alliance, which had long before been absolutely refuted, and which, moreover, had been sufficiently controverted in the lucid speech of Mr. Gerald Balfour when introducing the subject to the House. When we see such absolute disregard of truth in a matter we happen to have thoroughly mastered, we cannot help feeling that there may be many assertions of leading statesmen on political questions with which we have no such practical acquaintance which may be equally misleading.

A third impression of the debate was the equally painful one that there are, even on the Government side, a few members who have been led astray by these erroneous and mendacious assertions. They have probably been influenced by some of their confectioner constituents, and are not aware that the Brussels Convention will confer the greatest possible benefit upon that industry, while a continuance of the bounties would bring upon it reduced supplies, dear sugar, and a foreign monopoly. All this was clearly appreciated by the confectioners at the time of the London Convention in 1889, but their successors think they see a little further, and fancy that free trade in sugar may bring with it foreign competition in jam.

The whole debate is a curious instance of a Conservative Government fighting for free trade, and those who call themselves Liberals struggling for protection. Their sole excuse, which they no doubt regard as a valid one, is that they are only advocating protection to the foreigner.

Let us take the opposition first, and see what kind of a case they make out in favour of protecting foreign producers in our markets. Sir William Harcourt begins by twitting Mr. Chamberlain with the doctrines enunciated by the Board of Trade when he was President in 1881. Of course, as we all know, at that moment Mr. Farrer was master of the situation. Mr. Gladstone saw that the sugar question was getting him into an awkward position with some of his followers,

and, like a cunning parliamentary hand, hit upon the idea of shelving the subject by taking it away from the Foreign Office and handing it over to the tender mercies of the Board of Trade, which in those days was neither more nor less than Mr. Farrer. That able and energetic official did his duty well, and the sugar question was suppressed until 1888. An effort was then made to revive it, but Sir Thomas Farrer, who in the meantime had been rewarded with a baronetcy, was equal to the occasion, and succeeded in suppressing it for the second time. In 1898 a fresh revival took place, the energetic official had received a Peerage, and things were allowed to take their natural course. So much for the memorandums of 1881. They were refuted at the time, and the arguments used for that purpose have now become common property, and are generally accepted. The same fallacies, moreover, were flatly contradicted by a Committee of the House of Commons in 1880, though every effort was made to obtain a verdict in their favour.

Sir William Harcourt passes on to an attack on the penal clause of the Convention, and maintains that our Customs duties contain no instance of a countervailing duty, because our principle is the open door. He forgets that Sir Charles Cameron, one of his own supporters, showed in the debate of 1899, when an unsuccessful attempt was made to defeat the Government on this question, that our tariff was full of countervailing duties, and that the door is not open so long as bounties are permitted to give foreigners preferential treatment in our markets. The Convention will open the door, and no Convention can be had without a penal clause. Then he attacks the international Commission which is to decide what are and what are not bounties. This, he says, is putting the key of the open door in the hands of a European syndicate. He forgets that it is now in their hands, and that they have locked out the natural sources of production. The Convention unlocks the door, and "every source of supply is freely opened," in accordance with Cobden's definition of free trade. Sir William Harcourt prefers unnatural cheapness, which of course prevents every source of supply from being freely opened. His whole argument is based on this fallacy. Sugar, under Cobden's system of free trade, is stigmatized by Sir William Harcourt, as "dear sugar." Then he pities the Chancellor of the Exchequer, because he will be unable to calculate how much revenue he will get from sugar. The consumption will go on, and the usual sugar duty will be paid on it, so it is difficult to see the point of this argument, but it sounds alarming. Then comes the well-worn dictum that bounties are bad for the country that gives them, but good for the country that receives them. This is the ground fallacy of those who oppose the abolition of bounties. The reply is that bounties cause over-production, and it is only when that over-production has forced values below cost price that the consumer derives any benefit from the fact that foreign pro-

ducers are enjoying a position of protection in our markets. The consumer does not enjoy the unnatural cheapness long, because "every source of supply is" no longer "freely opened." Production is discouraged, supplies are reduced and prices rise. It is marvellous, almost incredible, that leading statesmen like Sir William Harcourt, clever officials like the late Lord Farrer, and a scientific journal like the *Economist* cannot take the trouble to think out the real effect of bounties from the consumer's point of view. They are always under the delusion that whatever be the amount of the bounty, that is the amount gained by our consumers. The theory is absurd on the face of it, but it is readily adopted by the casual reader. Sir William Harcourt, therefore, in his most portentous tone, declares that the consumers of this country are now gaining eight millions a year by the bounties, and will lose that sum when they are abolished. He does not inquire, he does not even take time to think; the assertion has been made and he accepts it. Any stick is good enough for an unscrupulous Opposition to flog the Government with. He entirely disregards Mr. Balfour's careful refutation of the fallacy. This would be well enough in the case of an ordinary party hack, but for a man who may be regarded as one of the leading statesmen of his day it is a little too bad.

But after all this, Sir William Harcourt turns round and argues that the abolition of bounties will not raise the price of sugar and, therefore, will be of no practical value. He devotes a considerable portion of his speech to the fallacy of a great rise in price, to the detriment of the consumer and the ruin of the confectioner, and then in a few words knocks down the creation of his own imagination, and sums up his contradictory assertions with the important admission that "the assumption that this is going to raise the price of sugar in a manner which will repair the losses of the West Indies is not well founded, as some people imagine."

Here is the answer to the confectioners, who are clamouring in every newspaper in the kingdom that members should vote against a measure which is going to raise our sugar bill by eight millions. Their own chief champion declares that even he himself has been talking nonsense, and that sugar will be no dearer.

The most-favoured-nation clause in our commercial treaties is then trotted out, and regarded as the most sacred institution of our whole commercial policy. It is really nothing of the kind. The countries with which we have such treaties are protectionist countries, and therefore, shut out all but those commodities which they are compelled to import from us. These they must have, treaty or no treaty. That the countervailing of a bounty is no infraction of the clause is perfectly clear. It is the bounty that frustrates the intention of the clause, and destroys the equality it was intended to secure. Countervailing the bounty restores the equality.

Sir William Harcourt concludes with a quotation of the reasons given by the Royal West India Commission for declining to recommend countervailing duties. The replies to their reasons are simple and brief, and could have been stated by Sir William Harcourt if he had given the subject a moment's consideration. (1) Countervailing a bounty has no more effect on price than abolishing a bounty. (2) Such duties have proved of no inconvenience in the United States or India. (3) There can be no uncertainty with regard to the benefit to be derived by the West Indies from the restoration of equality of competition and the cessation of the over production caused by bounties. (4) The most-favoured-nation clause in our treaties actually demands the abolition of bounties, which entirely frustrate its intention. (5) A Committee of the House of Commons has decided that the countervailing of a bounty is a measure perfectly consistent with the commercial policy of this country.

Those are the five simple answers to the five objections stated by the Royal Commission. But a much more conclusive one remains to be added. It is only necessary to admit the principle of countervailing a bounty, because it is impossible to obtain a convention for the abolition of bounties without such a penal clause. No Government in its senses would bind itself to abolish bounties unless it had security, in the penal clause, that its producers would no longer have to compete against bounties. That is the whole origin of the necessity for admitting the principle, and now that the principle has been admitted and the penal clause agreed to, abolition of bounties follows as a matter of course.

GERMANY AND THE BRUSSELS CONVENTION.

The Sugar Bounties Convention, which was signed on the 5th of March, 1902, at Brussels, by the Delegates of the following Sovereign Powers, Great Britain, Germany, Austria-Hungary, Belgium, Spain, France, Italy, the Netherlands, and Sweden, is an international acknowledgment that the whole system of protection by means of bounties, whether on export or on production, has proved a costly failure. It remains to be seen whether the Beet Sugar industry which has been established in Germany and Austria-Hungary, at the expense of the national capital of those countries, can continue its existence when exposed to free competition with the whole world. German statesmen have a difficult problem thrust upon them. The German economists can only deal with the problem as one to be solved by the science of economics, whilst the German statesman must be guided by the principles which make up the art of government; the economists, as such, have no concern with any other considerations than the economic operation of bounties on (1) the nation's capital, and (2)

the production, distribution, and exchange of the nation's wealth. It must then be left to the statesman to determine how far he can go in bringing his policy into accord with the true deductions of economic science. It requires no concrete experience of actual facts to enable the economists to determine both the effect of bounties on national capital and their effect on the national production of wealth, its distribution and exchange. The primary assumption of the economists is the innate and common impulse of man to seek ths satisfaction of his wants with the least labour; this is a law of nature, and the term "least labour" is in exact correlation with the "greatest assistance from nature." To produce "with the greatest assistance from nature" is conversely "with the least labour." Germany has the whole world to resort to for her consumption of sugar; the cost to Germany of the sugar consumed in Germany must be either the labour of producing the articles exchanged for it, or the labour of producing the sugar itself. Hitherto the German statesman has arbitrarily intervened by means of a protectionist device to prevent the law of nature asserting itself. If the convention has full operation, this arbitrary intervention of the statesman will cease and the populations of Europe will be allowed to evolve for themselves a supply of sugar with the least labour, that is, with the greatest assistance from nature. The source from which the German statesman has provided the sugar bounties is the national capital of his own country. Economic science is absolute in its conclusion that the trade of any country is in direct ratio with the capital of that country. Increase of capital is followed by increase of trade; diminution of capital by diminution of trade. It follows that if national capital is drawn upon to enable a particular trade to be carried on which otherwise would not be carried on, then that particular trade is being sustained at the expense of all other trades; in other words the draft on the national capital is the measure of the degree by which the statesman has ousted the law of nature and thus deprived the population under his care from obtaining what they require with the least labour, or conversely with the greatest assistance from nature. The greater such a stimulated industry grows, the greater the draft on the national capital, and consequently its diminution, and with such diminution the concurrent general diminution of the nation's trade. To exercise the art of government in such a way as to benefit one industry at the expense of all other industries is in conflict with the principle of justice; and however much policy and expediency, or what the statesman deems politic or expedient, are principles in the art of government, they have ever been held to be subordinated to the principles of justice. Is it consistent with justice that the whole population of Germany should be debarred from obtaining their sugar—one of the proved necessaries of life—from whatever source nature can with least labour supply it? When bounties are abolished, each of the contracting countries parties to

the convention will enjoy the unrestricted liberty of determining whether its supply of sugar for national consumption shall be obtained by its own production of the sugar or by its production of articles to be exchanged for sugar. The capital and labour of each country will employ itself to the best advantage by availing itself to the full of every natural advantage. The consumers will, on the cessation of bounties, enjoy their right of natural selection, and the sugar industries within the whole sugar area of the world will by their competition evolve the survival of the fittest.

This will be the general result of the abolition of all bounties, a result fully consonant with the deductions of economic science.

WALLWYN POYER B. SHEPHEARD.

The subjoined letter recently appeared in the *Manchester Guardian*. It is worth reproducing, as a few more fallacies about bounties are "nailed to the counter" by the writer:—

Sir,—Your correspondent, "G. H. P." argues that there are so many countries supplying us with sugar that there is no fear, if bounties continue, of our becoming dependent on the bounty-fed sources for our supplies. I find in a book issued under the auspices of the Confectioners' Alliance a statement showing that out of our total imports of sugar 91·8 per cent. comes from these bounty-fed sources. There is therefore a direct contradiction between the two statements.

"G.H.P." thinks he has crushed his adversary when he proceeds to argue that if prices do not rise with the abolition of bounties the West Indies will be no better off than they were before, failing to see that an average price of 10s. 6d. per cwt. with free competition is better than a similar average price made up of falls to 6s. and rises to 14s., as is the case under the bounty *régime*. A fall to 6s. caused by artificially stimulated over-production means ruin to the natural producer if it lasts long enough, and cannot be compensated by a subsequent rise to 14s., caused by reduced production, the closing of factories, and abandonment of estates.

Facts are stubborn things. A year ago the bounties had caused a great glut of sugar and a fall in price. Production has consequently been discouraged, supplies have been reduced by more than a million tons, and prices have risen. The late Lord Farrer said the result of bounties was "glut, collapse, and ruin." This will not happen when we have free trade in sugar, with all sources of supply freely opened to us.

I am, &c.,

GEORGE MARTINEAU.

Gomshall, 17th January, 1903.

THE COUNTERVAILING PRINCIPLE AND THE AMERICAN TARIFF SYSTEM.

Under the above heading the *Demerara Chronicle* discusses the question of the American system of countervailing, and adduces some information which goes some way towards explaining why the United States have so far not classed the Kartels as a bounty and countervailed them accordingly. Its authority is an article in the *Boston Herald*, of which it gives a summary. After tracing the rise of the bounty system in Russia, the *Chronicle* writes:—"In effect, the administration of the Czar's Empire enforces a combination which limits the quantity of sugar needed for domestic consumption, thereby keeping the prices at an artificial height and enabling the refiners to ship sugar at below cost price, the loss being made good from the large profits obtained from the domestic sales. The United States' treasury department decided, and correctly so, that this process constituted a bounty on Russian sugar and forthwith countervailed the product. It will be recalled that a trade storm arose out of the incident, which resulted in Russia imposing a punitive tariff on American iron and other exports. The sugar combinations of Germany and the Austrian Empire work in exactly the same manner as that of Russia, with this exception, that the kartels can only be said to have indirect Government sanction. The protective tariffs of both these countries prevent foreign-made sugars from entering into competition with home-made products, and thus the domestic price of sugar can with impunity be maintained on an artificially high basis. Why, we may inquire, has the American treasury department not followed up its precedent established in regard to Russia and imposed a compensating tax on the kartel sugar of the Austrian and German Empires? It is an illustration, we fear, of the impossibility of working the protective system in an absolutely logical way. Little considerations of expediency are apt to arise which make a slight departure from strict principle essential for the peace and well-being of the community. United States' officials had no doubt sufficient perspicacity to see that to retaliate against the consequences of the kartels would precipitate a "tariff war" in Europe against American goods at a time when such a movement would have been most injurious. They therefore elected to "let well enough alone," content in the knowledge that the domestic sugar interests are sufficiently protected to continue making substantial profits. The problem, however, has come up in another shape, and with the newest phase of the tariff question the *Boston Herald* deals. Recently a shipment of steel came from Germany to Philadelphia. The customs authorities refused to accept the invoiced price as the basis for computing the *ad valorem* duty. They contended that this was not the price at which

the shipment was purchased in Germany, and declared their intention of charging duty on the much higher artificial price exacted from the German consumer for the same steel or iron. As in the case of the sugar industry so also with the German steel manufacturers. They have formed a kartel which operates in the same way as the sugar combination. The matter has gone to the Philadelphia judicial authorities for judgment, and their decision will have an important bearing on the whole fiscal system of the United States. The *Herald* reverses the situation and contrasts the cost of certain home-manufactured articles to the American consumer by comparison with that charged to the foreigner. The price for steel rails is, says the *Herald*, \$28 per ton. "During the time that this price has prevailed shipments of rails have been sent to foreign countries which, at the price obtained, have represented a sale made at the American rolling mills of steel rails at a price not greater than \$18 a ton; that is, \$18 was the price charged to the foreigner, while \$28 was the price charged to the American purchaser." If, however, the *Herald* points out, the foreign government concerned, to whose country the rails are despatched, were to rule in the way that the customs authorities of the United States ruled, "it would say that the prices of these rails, no matter what was paid for them, was \$28 per ton, and the duty to be paid by the importer should be based on this high range of price, as the low range represented simply an arbitrary allowance made possible by the profits which the manufacturers secured through the monopoly of their market which our Government had accorded to them." The conclusion at which the *Herald* arrives is that, accepting the construction of the treasury department as the right one, it must be acknowledged that the Congress of the United States is paying an export bounty to certain American industries—"a practice which may be open to constitutional objection." In the Philadelphia case, the judiciary are virtually asked to decide whether a method which American manufacturers have adopted and applied in numberless instances is not in a certain sense contrary to the public well-being, at least to the extent of justifying prices thus made to be disregarded in officially determining questions of importation. The Russian and German systems are essentially the same as the American fiscal system. The kartels, or the official limitation of the domestic consumption, work in precisely the same way as the American trusts. They avoid over-stocking the home market, and sell to foreign countries their surplus products at such prices as they can secure, trusting to the large domestic profits to make good any losses on these foreign sales. This is undoubtedly a sound objection to the elaborate protective measures adopted by all three countries, and it is surprising that the masses of the inhabitants should be blind to the grossly unfair treatment they are receiving. The *Herald* questions whether it would not be possible to bring the American beneficiaries

of the Government bounty before the domestic Courts "as obtaining unconstitutional privileges through Congressional action." We have no doubt that if the issues could be properly brought home to the American people they would treat the present narrow protectionist policy of the country with scant tolerance. Incidentally, the *Herald's* comment supplies the best suggestion possible as to the means of fighting the trusts. The simple expedient of breaking down the Dingley Tariff barrier would solve the whole difficulty. But President Roosevelt and his party have not the courage to do this.

THE SUGAR CANE IN EGYPT.

By Walter Tiemann,

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I. General Cultivation.

Egypt has a good sound variety of canes to select from by means of which the planter can draw much larger land revenues than has hitherto been the case. In general the cultivation of cane is a neglected industry, but this is due to the customary systems of agriculture prevailing in Upper Egypt (the sugar cane is only grown in the country south of Cairo; in the Nile delta cotton is the staple industry), and to the innate conservatism of the Arabs, a characteristic naturally difficult to overcome, It is chiefly the large occupiers who cultivate sugar, and in this case it is not usually the owner himself who does the planting; he leases the land for each specific culture for a mutually fixed price and period. Hence it happens that with small culture, for instance, like clover, beans, maize, grain, onions, &c., the same ground is tilled within one year by several different tenants. In the case of sugar cane, the land is in the same hands for either one or two years. With this system it is clear that a particular individual will gain little by improving the ground and soil since he will reap little or nothing of the results of his careful labours. The ground is only superficially ploughed, and if the land chances to be leased ready ploughed, then the ploughing is particularly careless. Water is wasted, and should the quantity of weeds be inconveniently great, they are just left for the next tenant to dispose of. For these reasons the French Société des Sucreries, the possessor of the three large cane diffusion factories, has already been forced to take the cultivation of the cane into its own hands, and has, for this purpose, rented land for a large number of years. Of the three existent cane varieties in Egypt, the Red Cane is deemed the best for field and factory.

The writer at the commencement of his association with the industry found this cane already the richest in sugar, and he

subsequently developed it by proper treatment to a remarkable growth and yield. This red cane springs apparently from the Bourbon cane, or else is identical with it. For Egypt it may safely be considered the most suitable kind of cane from all points of view. The striped cane gives now and then a large return, yet is poorer in sugar content. The Yellow Cane does not attain to full maturity in Egypt.

The transplanting of the sugar cane is accomplished as follows:—The complete cane stems are cut up into pieces, containing about three nodes, and these cuttings are placed with their eyes sideways in prepared planting furrows, so that they can be covered with loose earth to the depth of about half an inch, whereupon watering by means of the adjacent irrigation canals follows. The cane planting requires a good well-worked-up soil, the interstices of which have been ploughed several times to a depth of 30 or 40 cm. Owing to the fallowness preceding the cane planting, large stony lumps are formed in the rich loamy soil when dryness sets in, and these have to be broken up by means of a hoe or a roller ere a porous soil can be prepared. Then by means of a wedge-shaped plough the plant rows are made of stated depth and distance apart. In the case of middling and good ground it is customary in Egypt to allow 0·9 to 1 metre for these interspaces; in poor soil they can be planted closer. In good ground the roots can be better developed by wider planting, and will then produce more and stronger roots, whereas a weak soil, as experience shows, yields no increase in quantity with a wider disposition of the plant rows, so in this case the planter's best plan is to employ a narrower interspace (about 0·8 m.) and produce somewhat more, if weaker, canes. The Arab system of planting, which consists of placing a convenient number of nodes of cane cutting into furrows filled with water and then treading them in with their feet, is to be condemned. With the increased application of manures, and as soon as one succeeds in obtaining by selection a yet stronger developed cane, it will be necessary to fix on yet wider interspaces so as to allow for the spread of the roots.

By means of careful selection the planter can yet distinctly improve the cane cultivation and thereby the crop yield. This point has been particularly neglected in Egypt. Hitherto the Arabs have employed any cane without distinction for fresh planting. One frequently sees cane so used which has been up to the factory and found unsuitable there; likewise cane laid low by storm which has been lying stunted in the irrigation water and is already infected with angelica! If the culture is to be improved, then the planter must begin by choosing good seed and by a careful and systematic selection raise the best seedlings. First of all one should choose from the differently situated fields at one's disposal the variety which shows on analysis the best sugar content, and to all

outward appearance seems the strongest growth. Isolated stem pieces are not of equal value for propagation as was found by the investigations carried out in 1897. The lowest part of the cane stem, though the richest in sucrose, is nevertheless the least suitable for transplanting and development of new plants. The most advantageous plan is to take only the top part, say, 3 to 6 nodes from the top. Every gardener knows that the youngest eyes are the strongest for sprouting, and the case is similar with the sugar cane. The cane tops are less profitable for the factory owing to their high glucose content, low proportion of crystallisable sugar, and low quotient of purity, whereas for transplanting they possess the greatest sprouting energy and yield the largest crops. In many parts of other cane growing countries, the cane tops are not taken to the factory at all, but are used either for fresh planting or else as fodder for cattle. In the latter case they possess through their albuminous nature as well as their carbo-hydrates a high nutritive value.

Should the cane be touched by frost, the tops cannot be employed for planting as the eyes will have been destroyed. To avoid the possibility of this occurring, it is as well to plant the cane somewhat earlier, providing the preparation of the new fields can be completed in time, but this plan is generally difficult to carry out in Egypt owing to the agricultural systems prevailing, and to the existence of other growing crops. An early planting about the end of November or beginning of December has everything to commend it for the full development of the same, as the writer himself found to be the case. It is most likely to result in a very good and well ripened sugar cane for the opening of the next campaign, whereas those canes planted according to the old custom in February, March, or April are anything but the first in sucrose content. If it be impossible to get the preparation of the fields complete ere the frost puts in an appearance, then it is only necessary to temporarily cover up the cuttings with cane leaves and loose earth so as to preserve them till planting time. The writer has seen canes which had been imported from India planted out in the fields, of which, after a forty-five days' journey in a sealed metal case, not a single cutting failed, but all developed into powerful growths. It is true that the Egyptian frost is only a surface one, and does not penetrate into the soil, yet years fully free from frost are somewhat rare. The last instance was the year 1896-97. Those who know the country say that such a favourable season comes but once in from five to ten years.

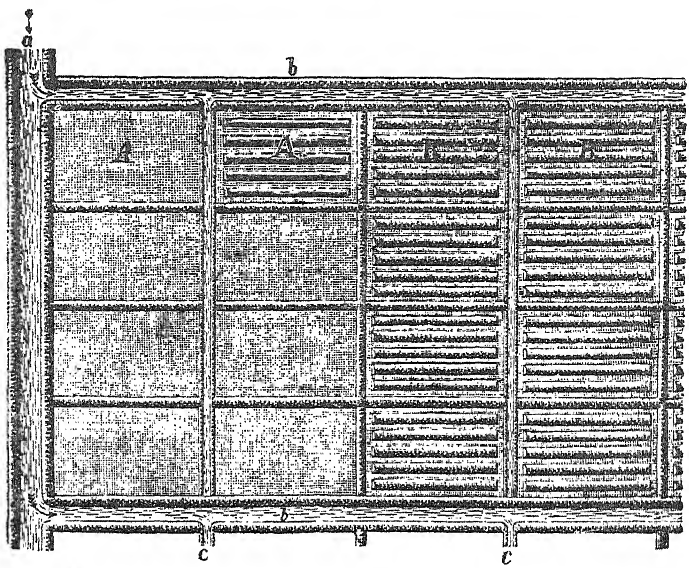
If the plants are surprised by frost before they are ready for it, then one has to fall back on the middle portion of the cane stem should the top eyes not be available, As a rule it is only the topmost portions of the stem which are touched by frost, and, perhaps, two to four eyes that are killed. The lower ones are more protected, thanks to the leaves, and hence are not so much exposed to the frost and

wind; these generally remain intact. The average fellah has a good eye for judging, as soon as he has been taught his business, as to which eyes on the cuttings should be chosen, and whether a particular eye will bud, or whether it is dead.

But if one is forced by agricultural circumstances to wait till February or March before planting, yet even when a frost has occurred, it is possible to achieve a good selection, as there are always some fields that have been less strongly affected, and from which the best portions should be chosen for analysis and exterior examination. An exchange of cuttings with different localities is likewise to be recommended, so that the same cane changes ground from south to north up and down the Nile. Moreover we can undertake the laying out of special fields for the planting of cane cuttings in suitable and favourably situated plots, such as are protected from the direct action of a north wind. In the Delta cotton district they have accomplished so much by selection, consequently their work is carried on with the greatest care. Why then should that not likewise be the case in Upper Egypt with regard to the sugar cane which is so openly grateful for the care bestowed on it, for proper treatment and for manuring, as the writer, in the course of his observations extending over a period of five years, realised from the results obtained. Let the choice of the plant canes and cuttings be placed in the hands of conscientious persons, such as have good natural powers of observation, and then in conjunction with the remaining necessary field work, the results will not be wanting.

A very necessary work in Egyptian soil is the hoeing of the cane. The local type of hoe, which the fellah understands well how to use, is a very suitable tool for this purpose. The upper surface of the ground being of a loamy composition, on being watered and then dried in the hot rays of the sun, hardens into a stony mass, so that after a long drought the field looks to all appearance as if paved with stone. Such a condition is naturally not a favourable one for the development of the root fibres and the ability of the plant to absorb its necessary food. Then weeds speedily grow and get the upper hand. Any farmer knows the value of the hoe for growing plants. For the sugar cane, the proper accomplishment of this work is of the greatest importance, and should never be neglected. The ground should be thoroughly loosened and freed from weeds. In the case of second year cane the hoeing can be done advantageously by ploughing between the rows. A double hoeing should suffice. The correct time for this work depends on the weeds and on the conditions of planting, but should be finished by the time the cane leaves completely overshadow the ground. Following this comes the heaping up of the soil on the young cane plants as far as the stems are bare. By this last work the mounds which previously acted as dams are changed into furrows which further the irrigation.

The irrigation of the cane fields must receive the best attention and strictest supervision on the part of the cane planter from the very commencement of planting. The land must before all things be well levelled so as to ensure an even irrigation. There should be no deep places, as is unfortunately too often the case where the cane is brought to the ground by inundation, and the results entirely spoilt. A proper and well carried out drainage is of as great importance for obtaining good canes as is the watering. Stagnation of the water in the fields must be avoided under all circumstances. The cane is no aquatic plant, and requires for its normal success a well ventilated soil. Should the water remain in pools on the fields, then oxygen is absorbed and the roots are choked in the literal sense of the word. The men who look after this irrigation work remain day and night at their posts in order to remedy any irregularity, for if the work be carelessly done in a single instance, the mistake is difficult to repair. One soon gets to know such bad spots in the fields by the pale yellow colouring which is taken up by the canes as though for want of nitrogen. In particular, at the commencement of growth it is advisable to water sparingly and often, employing the greatest care.



The accompanying sketch shows the usual plan of watering adopted. From the main canal smaller streams branch off to the canefield, so that the latter is interwoven with a complete network of canals, and the water is thereby conducted with ease on and off the field. For watering the separate divisions the intervening dams, of a

foot in height, are opened with a hoe. When cultivation is first started each section is treated by itself, but when the canes get more advanced several are treated at the same time. In the first period the watering is carried out sparingly at intervals of ten days; when the cane is fuller grown once a fortnight suffices. The work should be done with regularity, and not excessively. As the time approaches when ripening ensues, the canefields are left for one or two months without any irrigation in order to give the same a rest, this being necessary to ensure full ripening and formation of sugar, as well as to aid in the complete transformation of non-crystallizable into crystallizable sugar. The juice must come to rest in the stem, and the sun have time to carry out its invisible work. And if too much watering is done in this period of manuring, then the physiological action of the sun's rays will be rendered useless, and the watering will deprive the cane stem of its sugar. Nor can the writer agree with the idea held by some Arabs that the frost does no damage when the canes are under water. The best case is where in a wind-protected spot the frost does no damage even in the absence of water. The main cause of danger lies in the wind which rises in conjunction with the frost. As soon as a body changes from a dense to a rarified condition cold ensues. With the advent of strong winds large masses of water are evaporated, which then bring on keen, if momentary, cold. This notwithstanding, the Arabs go in for excessive watering up to the harvest time in order to gain an increased weight. The writer kept his experimental field, which was likewise exposed to frost and bad weather, for one and a half months before reaping without any irrigation, and in spite of that had less damage from frost and a higher yield and sugar content than did the fellahs' canes. For small fields which the fellahs cultivate on their own plan, the old primitive arrangements for rising deep lying water to the level of the fields still hold. In this case one still sees at work a large number of draw wells (shaduf) and simple winding apparatus (sakieh), the latter being a series of box-shaped scoops arranged like a dredger, either hand or cattle power being employed to drive them. Watering apparatus, driven by hydraulic power, is only to be met with in Fayun, as the Nile canals have such a gentle fall. Where these primitive apparatus do not suffice, various portable or fixed steam engines are employed as well. In the larger plantations, where the fields generally lie together on fairly large plains, big pumping plants are necessary to bring the water from the large canals, or even from the Nile direct, into the fields. These are generally centrifugal pumps driven by steam engines of about 200 H.P. For each watering about 1,000 cubic meters of water are required per hectar (500 cubic meters per feddan = 1·24 acres), and the size of the pumping plant is arranged accordingly.

(To be continued.)

RECENT PRACTICE IN THE DESIGN, CONSTRUCTION, AND OPERATION OF RAW CANE SUGAR FACTORIES IN THE HAWAIIAN ISLANDS.

(Continued from page 34.)

Results.—The factory commenced operations on 29th January, 1902, as has been already stated. Owing to a comparatively short crop—22,000 tons of sugar being the estimate previous to 1st January, 1902—and a scarcity of labour, it was decided to operate only one milling plant, so that the following figures refer to the operation of one-third of the full capacity of the factory. The machinery in operation consists of:—

1 Crushing plant, and one set of elevators and conveyors for bagasse.
6 Boilers.
1 Set clarifiers and sand filters and 8 filter presses for scums.
1 Evaporating apparatus.
4 Vacuum pans worked at half speed.
12 Crystallizing tanks of the Bock system.
16 Centrifugal machines.

The adjustments of the three mills and their returner bars took some little time. The crushing was at the following rated capacity:—

Total cane ground on day of trial	1,148 tons.
Total hours run	22 hours 50 minutes.
Cane ground per hour	50·28 tons.
Revolutions of engine per minute	48.
Moisture in bagasse..	45·3 per cent.
Extraction of sugar on that in cane..	93·4 per cent.
Density of first mill juice solids in solutions....	20·8 per cent.
Density of last mill juice solids in solution ..	12·3 per cent.
Maceration water added to cane between the mills, gallons per 100 gallons of original juice..	18·1.
Average power developed by engine driving mills, crusher, crane carrier, and bagasse elevator..	320 H.P.

The horse-power as shown is very much below the power usually developed in crushing plants of this capacity, which is from 400 to 450 H.P., and even reaching in extreme cases as high as 600 H.P.

The comparatively small power required on this particular plant is due, first, to driving the whole of the machinery connected with the crushing and conveying of cane by one engine, thus doing away with internal engine friction; and, secondly, to the form of the rubbing surface on the returner bars, and extreme care in setting these bars parallel to, and the proper distance down from the top rollers of the various mills.

The analysis of the bagasse discharged by the last mill showed a water content of 45 per cent., this being taken at the jaws of the mill, and since the water sprayed on the cane has a temperature of 170° F. the bagasse is ejected very warm; being in a very finely divided state, it rapidly loses its heat and a proportion of its moisture on its way to the furnaces, the moisture in the bagasse entering the furnaces being only four-fifths of that leaving the last mill. The bagasse produced during the day's run was 280 tons, which lost on its way to the furnaces 20* per cent. of its moisture; the weight reaching the furnaces being 255 tons, of which 30 tons was surplus; the remainder (225 tons) was burnt in six furnaces, each having 36 square feet of grate surface, consumption of bagasse per square foot of grate surface per hour being 87 lbs.

The total heating surface in the six boilers amounts to 15,600 square feet, and the consumption of bagasse per square foot of heating surface per hour amounts to 1·2 lb. The high consumption of fuel per square foot of grate surface is due to strong draught, which, with the very open and fibrous nature of the bagasse, admits of an intimate contact of air with all particles of fuel, thus ensuring a very rapid and complete combustion. The ash and slag resulting from the burning of the bagasse amounts to from 1·25 per cent. to 2 per cent. of its weight, depending greatly on the amount of silica in the outer skin of the cane.

The draught pressure at the base of the chimney is $\frac{1}{10}$-inch of water, measured by an ordinary draught gauge, and the temperature in the uptake from the boilers is 540° F., taken with an immersion pyrometer. No means exists here for obtaining the temperature of combustion in the furnaces, but judging from appearances it must be approximately about 2,200° F.

Number of days grinding up to and including 30th April, 1902.	70.
Number of hours grinding in this period	1,559⅓.
Percentage of grinding time to total operating time paid for ..	92·8%.
Tons of cane ground up to 30th April, 1902	66,672.
Tons of cane per hour, average	42·7.
,, ,, ,, maximum	56.
Tons of cane per day, average	952.
,, ,, ,, maximum	1,243.
Average yield of commercial sugar per 100 of cane to date ..	13·19 lbs.
Average purity of commercial sugar	96·5%.
,, ,, A sugar, 70% of sugar shipped	96·5%.
,, ,, B ,, 30% ,, ,, ...	95%.
Total commercial sugar made to date	8,785 tons.
Tons of cane to make one ton of commercial sugar	7·59.
Recovery of pure sugar from that taken into manufacture :—	
Pure sugar in sugar marketed	91·3%.
Losses in manufacture	8·7%.
	100·00

*According to the data given here this should be under 10% loss.

Average extraction of pure sugar from that estimated to be in the cane	92·46%.
Fuel used in starting factory :—	
Wood	14 cords.
Coal	33¾ tons.
Total number of men employed in and about factory day and night	160.

Sufficient surplus bagasse is always kept stored in front of the boilers to keep up steam for three days, thus ensuring a supply of fuel in case of stoppage in the delivery of cane for any reason, so that the stock in process can be worked up, and the house cleared of all high-grade sugars without the necessity of using auxiliary fuel. A large margin of bagasse is saved in excess of this surplus, and is used in conjunction with coal for keeping steam for the irrigating pumping engines, of which this company has six, with an aggregate capacity of 40 million gallons of water per day to an average height of 235 feet.

The total amount of bagasse delivered to the pumping plants up to 30th April, 1902, was 637 tons.

Construction.

The construction of this plant was practically begun in October, 1900; some clearing and excavations had been done previously, but a permanent force of men, under the supervision of the superintending engineer, were actively engaged in this month, the arrival of material commencing in November, 1900, and in February, 1901 the foundations were far enough advanced to commence the erection of the buildings. The construction of the structural part of the buildings was completed in September, 1901, and in October, 1901, the sheet-iron covering for roofs and sides of building was completed. The machinery commenced to arrive in May, 1901, and was immediately put in hand, the foundations and bolts having been made and set from special drawings. All the foundations throughout were made of concrete in the proportion of one barrel of cement, five barrels of sand and six barrels of crushed rock; this amount of material making $\frac{7}{8}$ cubic yard of concrete. This was well rammed in boxes properly laid out, where foundations came above the floor line; two inches next the boxes was filled with fine concrete, made of one barrel cement, three barrels of sand, and four barrels of fine rock-screenings, to give a good finish to the exposed foundations. All bolt-holes were left 3 inches larger than the bolts, and were filled with cement grout when machinery was placed. Boiler settings were made of hard red brick with fire-brick linings; all fire-brick arches over furnaces and other places were made of specially selected brick put in dry, bricks being cut and fitted to radius required; fire-clay was very sparingly used on the vertical linings; no stay-bolts of any kind were used in the brickwork, the thrust of arches being taken up

on heavy walls, and the boilers hang 2 inches clear of brickwork in all directions, the space being filled up with asbestos packing. This method of construction permits the free expansion and contraction of the boiler without throwing any strains on the enclosing brickwork, and has proved excellent.

The steam-pipes throughout the plant are made of lap-welded steel pipes tested at the factory to 500 lbs. per square inch. They are joined by heavy cast-iron flanges bored out, driven on to pipes which are then expanded into the flanges by riveting; the projecting ends of pipe were riveted down and cut off flush and straight. All elbows and tees are of cast-iron, large sizes being flanged, and small sizes screwed. The piping itself is designed with free ends to avoid the use of expansion joints, the main pipe lines being solidly anchored near the middle of the buildings to convenient columns, and hung from the floor beams so as to be free to expand outwards from the centre. In one instance only an expansion joint was placed, as the ends of the pipe were locked between columns, and means for taking up the expansion at this point became necessary. The steam-pipes are all covered with non-conducting jackets; the small sizes from 4 inches diameter down have magnesia covering 1 inch thick. The larger pipes up to 18 inches diameter have air-space covering made of strips of wood 1 inch by 1½ inch laid longitudinally and 3 inches apart; over this was wire-netting of ½ inch mesh, then three layers of heavy manila paper, and the whole covered with cotton cloth and whitewashed.

The material used in the construction of this factory is as follows:—

Concrete in foundations and floors..	8,000 cubic yards.
Steel and iron in buildings	3,000 tons.
Machinery	2,500 tons.
Lumber in floors, &c.	250,000 feet B.M.
Glass for windows and skylights	8 tons.
Paint	3,500 gallons.
Bricks in boiler settings and chimney linings	500,000.
Railroad tracks in storage yard	6 miles.

Statement of men employed, and time occupied in construction, is as follows:—

		Men.		Months.
On buildings	skilled	7	....	8
,, ,, ...	unskilled	85	....	8
On machinery..	skilled	20	....	10
,, ,, ...	unskilled	100	....	10
Foundations and sundries .. .	skilled	2	....	14
,, ,, ...	unskilled	30	....	14
One superintending engineer				16
One draughtsman				14
One receiving and shipping clerk				16

The design and carrying out of this work is due to the Honolulu Iron Works Co., the responsible man being Mr. C. Hedemann, the manager; owing to the short time given to complete the work, the bulk of the material and machinery was constructed in the United States to specifications drawn up by the Honolulu Iron Works Co., Messrs. Milliken Brothers, of New York, supplied the buildings; the Kilby Manufacturing Co., of Cleveland, Ohio, supplied the vacuum pans and crystallisers; the American Tool and Machine Co., of Boston, Mass., furnished the centrifugal machines, under the patents of Messrs. Watson, Laidlaw and Co., of Glasgow; the Sugar Apparatus Co., of Philadelphia, furnished the evaporating apparatus; the Link Belt Machinery Co., of Chicago, furnished the elevators and conveyors for bagasse, &c.; the vacuum pumps for the vacuum pans and evaporating apparatus were furnished by the Blake Manufacturing Co., of Boston and New York, and Messrs. Guild and Garrison, of Brooklyn; while the Honolulu Iron Works Co. supplied the mills, boilers, and sand filters. The remainder of the machinery, such as tanks, large steam-pipes, water-pipes, &c., was constructed on the spot from materials furnished; the filter presses, small pumps, &c., were brought over from the abandoned plant. The erection of and connecting of pipes to the machinery was finished and the factory started on 29th January, 1902. There were no hitches or accidents, and the factory has been in operation steadily ever since.

Operation.

Process of Manufacture.—The first step in the process of manufacturing raw cane sugar is the crushing of the cane. This cane is all weighed before being discharged into the crusher conveyors; at first sight it would seem a simple matter to determine the amount of sugar present in the cane, but in reality it is most difficult, the chief trouble being in obtaining an average sample. In this factory the weight of sugar taken into the factory after leaving the crushers is what is used to determine manufacturing losses; but the control of the crushing is obtained by regulating the amount of water sprayed on the crushed cane between the mills, so that the density of the juice issuing from the last mill is kept at a constant figure, which has been found by careful experiment to ensure a certain percentage of sugar in the cane refuse ejected after the final crushing when a certain amount of moisture is present. The moisture is regulated in the last crushing by the pressure on the top roller, and is therefore readily under control by adjusting the weights on the hydraulic accumulator. The density of the last mill juice is regulated by increasing or decreasing the amount of water sprayed on the cane, and consequently, after the degree of density of the last mill juice requisite to reduce the sugar in the cane refuse to the required point has been determined, the control of milling operations becomes a simple matter of routine.

In this factory the moisture in the bagasse is kept as near 45 per cent. as possible, the density of the last mill juice is kept at 12 per cent. solids in solution, and the amount of sugar left in the cane refuse varies from 4·5 per cent. to 5 per cent., which is equivalent to from 92·5 per cent. to 93·5 per cent. extraction of sugar on the sugar originally in the cane depending upon its content in woody fibre. The extracted juice on leaving the mills is weighed into the clarification apparatus already described, and the weight of juice multiplied by the percentage of sugar shown by the average sample gives the weight of sugar taken into manufacture. After being reduced to syrup, it is again weighed and sampled, and the amount of sugar taken over determined; the difference between this and the amount of sugar taken into the house constitutes the loss between these two points. The sources of this loss are as follows: mechanical losses in transit; losses in the scums and refuse thrown into the sewer (these scums are weighed and analysed before discharge, so that the loss is known); losses in the wash waters from the juice filters; and losses by destruction of sugar due to use of reagents, such as lime, phosphoric acid, sulphurous acid, &c., and also losses by entrainment, or the carrying over the minute particles of syrup into the condenser in the evaporating apparatus; these losses, excepting that due to discharge of scums, are usually very small; should they exceed a certain small figure, the cause is at once determined and corrected.

The syrups and molasses, after having been exhausted of all the sugar obtainable, are divided into two portions, first, the marketable sugar, of which the weight and purity is known; and second, the waste molasses, which is weighed and sampled. The sugar in the waste molasses, added to the pure sugar in the sugar marketed, will not equal the sugar in the syrup; the difference is the loss in process, and consists of a certain disappearance of sugar in the vacuum pans, and mechanical losses in transit of syrups and molasses from operation to operation. These losses are generally very small, but if they are large enough to attract attention it is usually found that carelessness in the operations is the cause.

The analytical work in this factory is in the hands of a chemist, who has several assistants whose duty is to collect the samples from the various processes, weigh and polarise the juices, syrups, and sugars, and do the routine work in the laboratory. The whole work is carried on under the charge of the superintendent; the men in charge of the milling department keep a regular engineer's log-book, in which are noted the daily occurrences, a recording steam pressure-gauge notes the varying pressure of steam in the boilers. The main engine is indicated occasionally to note how the valves work, and also to note if any undue horse-power is being developed on the mills, since the power required can very readily be greatly increased

by bad setting of the returner bar in the mills. In the log-book are also noted any slight repairs that may be needed from time to time, and from these notes at the end of the crop is determined the improvements in the milling plant if any are needed.

The sugar-boiler, with assistants, attends to the clarifying and tempering of the juice, the filtration and concentration of same to syrup and the boiling to grain; he is responsible for the quality of the marketable product. A record is kept of every boiling of syrups and molasses, and from these records, together with the results of the sampling and analytical work by the chemist, the work done in this department, as to quality and quantity of raw sugars made, is kept up to as high a standard as possible. The sugar weigher makes up an account every day of the amount of sugar bagged, shipped, and on hand.

The chemist makes up a daily report showing weight of cane ground, weight and analysis of juice taken into manufacture, analysis of scums, sugars, and molasses, and weight of final molasses discharged; he also makes up a weekly report, and, at the end of the season, a final crop report.

The superintendent of the sugar-house makes up a monthly report, in which is detailed the cost of each department, the cost of materials required in the manufacture of sugar, the total sugar made, total cane ground, the cost of sugar made per 100 lbs., and cost of cane ground per ton of 2,000 lbs.

At the end of the crop the superintendent of the sugar-house makes up a final report, which is an abstract of all the reports, giving days of operation of machinery, stoppages and causes for same; percentage of running time to total time paid for; total sugar made and cost; also a statement of all losses. In this report is included any recommendation that may have to be made regarding additions or alterations to plant, improvements to operations, and such other communications as may seem to bear upon the points of reduction in cost of manufacture or reduction of losses.

The discussion which followed the paper was of considerable interest.

Mr. Andrew Brown was the first speaker. He inquired what was the area of ground round the factory under cultivation such as would supply 3,600 tons of cane per diem, and he considered that at least five or six square miles of territory would be required. He also commented on the use of sand filters in the Hawaiian factories as compared with the use of animal charcoal at home. Referring to the vacuum pans described in the paper, which were 10ft. 6in. in diameter, with a conical bottom, and a straight belt 15ft. high, he expressed disapproval with this form of pan. He considered that the best form of pan was that which gave large diameter and less depth. A rapid action was desirable; the coil was mentioned as containing 1,000 superficial feet of heating surface

divided over 16 2-in. copper coils; there would therefore be 2,000ft. run of pipe in 16 separate coils. The speaker considered that the pipes should be 4in. in diameter, and be short so as to easily get rid of the condensed water. The speaker next, by the aid of a sketch on the blackboard, illustrated a method of getting rid of the condensed water in the vacuum coil. Steam was admitted through a valve into a common box, with which communicated a certain number of concentric rings of pipe. On the opposite side of the pan was another receptacle in connection with the rings of pipe; the incoming steam would pass in either direction through the coils, and, entering the receptacle on the opposite side, the resulting water would be carried away to the bottom of the pan, where it would be trapped off. Dealing with the centrifugals, the speaker said that the usual practice with them was to have a peripheral speed of 8,000ft., but from the details submitted by the author it appeared that the speed actually worked out at about 10,000ft. per minute. He wondered what kind of baskets were used in this case, and as to whether they were specially strengthened. Dealing with the air chamber, said to be 60ft. high, which was used to steady the supply to the centrifugals, he thought that it was costly and unnecessary. It was not adopted in this country for the same pattern of centrifugals.

After discussing the grades of sugar turned out, and the employment of bagasse at the boilers, Mr. Brown concluded his observations, and was followed by Mr. W. Price Abell, of Derby, who said it was very appropriate that Mr. Williams had introduced his most interesting paper at a time when the baneful effects of the unjust continental bounties were on the point of being done away with. He was, however, sorry that the magnificent factory described by him was not on English ground, as it might have been had it not been for the ruin caused by the bounties. It was a further illustration of the care taken by our neighbours of their colonial industries.

He noticed that Mr. Williams gave the yield of commercial sugar at about 12 lbs. per 100 lbs. of cane, in fact later on in the tabulated returns he gives 13 lbs. This was remarkable, but was not entirely due to the perfection of the manufacture, in fact a very great part was due to the cultivation resulting from the very favourable conditions under the irrigation system they had in Hawaii.

For the building they were fortunate in having stone foundations, allowing a load of 3 tons to the square foot, whereas in Demerara it was impossible to allow more than half a ton to the square foot, and this applied to soft ground in general.

The unloader adopted by the factory described in Mr. Williams' paper was far in advance of anything Mr. Abell had seen, in fact it appeared to practically get over what had hitherto been an almost insurmountable difficulty. As they knew, many schemes had been devised; the speaker well remembered seeing a most elaborate

apparatus for lifting a truck or punt bodily and emptying the same into the megass carrier.

Engineers would take decided exception to the boilers used in this factory. They are given as 20 feet long, having 4 inch tubes. Now from the speaker's experience in Demerara, the practice of making the length of the tubes 40 times the diameter was found the most efficient. This resulted in boilers averaging 12 feet long. As engineers recognise that the first 3 feet of heating surface in a tubular boiler practically do all the work, this abnormal length of 20 feet would somewhat throttle the draught, and would have been far more effectively utilised if divided into two boilers. Then with regard to the reduction in the width of the fire grates by building up underneath the fire bars, the speaker's experience very distinctly pointed that they would have made them considerably more efficient had they continued building up through the grate, the hot bricks through radiation and contact playing a necessary part to the efficient combustion of the bagasse or megass. The speaker quite recognised the difficulty of doing this, and met the same with step grates some few years since.

The juice strainer described would certainly not be so efficient as the revolving perforated vat used on some Demerara estates. This vat is keyed on to the top roll shaft, and is of sufficient diameter to receive the juice discharged from the mill, the cushcush being carried round in this towards the top, from whence it falls off on to the shoot discharging it again into the mill, while the liquor finds its way through the perforated sides. This arrangement is absolutely automatic, self-cleaning, and remarkably simple.

The evaporating apparatus, giving 5 lbs. per square foot of heating surface in the four bodies, is remarkably good, and is somewhat explained by the fact that the heating surface is new and consequently clean.

Mr. Williams' statement that 3 tons of megass containing 45% of the moisture is considered equal to 1 ton of ordinary Australian coal is interesting when compared with the equivalent of Egyptian sun-dried megass, which Dr. Letheby found took 2·09 tons to be equal to 1 ton of coal, in fact one corroborates the other; the fact that one was sun-dried and the other green would easily account for the difference.

Further, it is interesting to note that they use molasses as fuel, and that its calorific is equal to that of megass, or one-third that of coal, and considering that they have at Maui 60 to 200 gallons per hour of these molasses, or, taking an average of 1,300 lbs., running into say 12 tons per day, they have on the whole grinding of 70 days a considerable addition to fuel, equivalent to 840 tons of megass.

Looking at the analysis of work during the first grinding, one is struck with the percentage of grinding time to total operating time paid for being 92·8%, a fact which unmistakably points to splendid

engineering organisation and skill having been carried out during the whole of the erection, for, as everyone knows, the first running of a vast set of new machinery as assembled in the Maui factory would, on the slightest bad workmanship in any part requiring attention, have necessitated the stoppage of the whole factory. One is also struck with the good return of 13·19 lbs. of commercial sugar per 100 lbs. of cane.

As the result of working, it is interesting to note that the amount of megass derived from the crushed cane after running the factory left a surplus of 637 tons for use at the pumping plant. Now this at first blush appears to be all that can be desired, but when it is remembered that at Maui they not only do not utilise molasses for making rum, involving the use of considerable extra fuel, as is done in the sugar estates in the West Indies and particularly in the efficient factories of Demerara, one is persuaded to think this fuel question deserves attention. In fact, the speaker knows several estates in Demerara where even eight or nine years ago far better fuel results were obtained from very much older machinery—lower boiler pressure, only day work instead of continuous running!—than is obtained at Maui; as proved by the following extract from a paper read by the speaker before the Institute of Civil Engineers, Vol. CXXII., Session 1895-96, Part I.:—

"The results of long grinding at a factory producing 1½ tons of "sugar per hour show that the amount of megass available per hour "is 3·75 tons, consisting of 2·03 tons of fibre and 1·72 tons of water. "This is burnt in five furnaces, 4·24 cubic feet of megass being thus "available for each furnace per minute; but sufficient steam is main-"tained with 3 cubic feet per minute. Each furnace has a grate-area "of 20 square feet, and each supplies heat to a multitubular boiler "containing 1,300 square feet of heating surface. The chimney "draught, as shown by a Bailey draught-gauge, is 40 feet per second; "the flue temperature, as shown by a Bailey pyrometer, is 500° F.; "and the furnace temperature is such as to melt copper and partially "melt cast-iron, about 2,000° F. In addition to extracting juice "from the canes with a pressure of 250 tons on each of the top rolls, "the water is evaporated, the sugar is cured, and the molasses is "converted into rum and second sugar. The 3·75 tons of megass "develop the requisite power without the assistance of any other fuel, "the duty of the engines employed amounting to 463 I.H.P., and the "heating surface in the evaporators being 5,650 square feet."

At this factory very little diffusion water was added, but what more than counteracted this was the fact that the factory did not work the 24 hours through, and consequently every night a considerable cooling down of furnaces and heating apparatus took place, and considerable fuel was required to get everything started afresh in the morning, whereas at Maui they run continuously for 24 hours. The amount of

rum made at the former factory varying between 30 and 40 gallons per ton of sugar.

Taking these results into consideration, and they are not isolated, it appears to the speaker that with more efficient furnaces at Maui, instead of having a surplus of 637 tons of megass to their 70 days' grinding, they ought to have had twice that amount, plus the equivalent of molasses used for fuel, which, as previously stated from the data given, amounts to 840 tons, giving in all a total of over 2,000 tons of surplus megass for use at their pumping engines. It would be invidious to say more in regard to furnaces at this juncture.

The factory is doubtless a very fine specimen of centralisation, but in this case particularly the question arises, how it pays to centralise? and at what point was the acme of commercial economy reached? As pointed out by Mr. Brown, this enormous factory requires canes grown on a very large area of land. As all cane growers know, the sooner the cane was in the mill after leaving the cutlass, the less the loss is from inversion; whilst from an engineering point of view we recognise that there is a very definite limit to the commercial efficiency of engineering units. Whether this has been overstepped at Maui so far appears to be an interesting and open question.

Mr. David Martineau next followed, and expressed astonishment at the enormous size of the factories and the distance of the fields from the mills. He thought that as there was a time limit to the preservation of the cane, it was a question whether this was not at its maximum here. He criticised some of the processes in use, and thought that the char filters, as used in this country, were superior to the sand filters in Hawaii. The burning of molasses he considered a wasteful process, and asked why it was not used for making rum as in the West Indies.

Mr. Claude T. Berthon, after discussing the arrangement of the mill rollers and of the bagasse turner, went on to mention the application of electricity in centrifugal driving. He referred to one pattern recently placed on the market.* It was so well balanced on almost frictionless bearings that a load of 800 lbs. could be turned by one finger at the circumference. But one of the chief features of this machine was the device for dispensing with a rheostat. The motion of the motor was transmitted to the spindle by means of a friction coupling consisting of several radial arms with friction surfaces at their extremities. By this means the motor could be started without any load, but once the speed increased the centrifugal force generated brought the frictional arms into play, and thus picked up the machine. A machine of this type had been working satisfactorily for the last five or six months. One advantage of this form of driving was that the power required during the running could be accurately gauged

* Messrs. Pott, Cassels & Williamson's patent.

by an ammeter; this instrument showed that the supply of current was not constant, but fell away greatly during the run of the machine until the molasses had passed away.

As the author of the paper was not in England at the time of the reading of the paper it was impossible to have his prompt reply to the criticisms, but a copy of the latter would be sent him, so as to give him an opportunity to reply.

ON THE CRYSTALLISATION OF SUGAR BY COOLING AND IN MOTION, AND ITS SOLUBILITY.

By M. Fradiss.

Although crystallisation is the main feature, and the most important one too, in the manufacture of sugar, yet it has been very little studied till just recently, and may still be considered in its infancy.

When employing the old system of crystallisation in open pans, we were little preoccupied in ascertaining whether the operation had been all that it ought to be—that is, whether it had reached the maximum yield of sugar crystals, and whether the molasses could not have been better exhausted. We merely grasped the final results without knowing how they were brought about.

But since crystallisation by cooling and in motion has made its appearance, and has entered into the practice of sugar factories (thanks to the processes of Manoury, Steffen, Freitag, &c.), the fabricants have perceived how little this branch of manufacture was known, and to what an extent they have lost by groping more or less in the dark.

The questions arise:—What method should be followed to obtain the maximum of crystals and the most exhausted molasses? What should be the "curve" of cooling? At what point should the "contraction" of a masse-cuite in cooling take place? What should be the initial purity of the mother liquor of a masse-cuite to attain the maximum exhaustion of the runnings, &c.?

I do not profess to be able to solve these questions in a decisive and complete manner, but I propose to indicate in these notes the principal points necessary for the chemist's consideration, and to open out for the latter a path which will enable them to carry on crystallisation at the will of the manufacturer, and thereby to obtain better results, *i.e.*, more crystals and more completely exhausted molasses.

Although many chemists, such as Horsin-Déon, Herzfeld, Claassen, &c., have made numerous experiments in crystallisation, the application of their results to practice has been hindered for want

of an essential basis, which exists in the solubility of sugar in water in the presence of the impurities of sugar products.

To promote a deposit of sugar in a sugar solution, two methods are generally employed. The first consists in evaporating the sugar solution, and when the point of saturation is exceeded the sugar is deposited in the form of crystals.

The second method is to saturate a sugar solution at a high temperature, and to cool it progressively, while at the same time stirring it; in lowering the temperature, and thereby decreasing the saturation point, the sugar is deposited in crystals. In short, if a syrup is saturated at 90°, for example, and if we then lower its temperature to 80°, the saturating point is lowered too, with the result that a deposit of sugar, corresponding to the difference in the solubility of sugar at 90° and 80°, takes place; if we continue to lower the temperature to, say 40°, we promote fresh deposits of sugar which correspond equally to the difference in the solubility of sugar between 90° and 40°. We see from the foregoing that in order to foresee, calculate, and control the results of crystallisation, it is absolutely necessary to know the solubility of sugar in the products of sugar making.

Thanks to the labours of Herzfeld and Flourens, we have tables of the solubility of sugar in pure water, which is already the first step in the study of crystallisation.

But, unfortunately, these tables are not applicable in the sugar industry where crystallisation always takes place in a more or less pure medium, and in the presence of "non-sugars."

Experiments have shown me that the quotient of purity of a product has a very considerable influence on the solubility of the sugar. The relation of sugar to water (which is $\frac{S}{W}$), and in the products of sugar working, is in direct proportion to the purity of the product. The higher the purity, the more nearly the relation approaches that in the tables of Flourens and Herzfeld; and, conversely, the lower the purity the more dissimilar it is.

Thus, for example, at 80° the relation of sugar to water is

3·62 in pure water (Flourens),
3·65 at 95 of purity,
4·20 at 75 ,,
4·80 at 60 ,,

and so on.

It will suffice to consult the tables. On glancing at them it will be seen that the impurities considerably increase the solution of sugar in water. I have determined the relations of sugar to water at all degrees of purity, and have grouped them in the subjoined tables. I

worked on syrups saturated hot, containing crystals to induce and accelerate crystallisation. To avoid supersaturation, it is wise to work on a masse-cuite containing about 50% of crystals. This masse-cuite, saturated at 95°, was cooled in a small laboratory crystalliser of about 30 litres capacity. One could cause to circulate within the double partition of the crystalliser either cold water for cooling or else hot water for maintaining the masse-cuite at a known temperature according to one's requirements. The masse-cuite was constantly stirred by means of a small electric motor of one h.p.; after the manner of the mother liquor, it was analysed, separated from the crystals on cooling, and analyses were taken of each fall in temperature and each fall of purity.

The separation of the mother liquor from the crystals is a very delicate operation. The most expeditious and simple method, which allowed one to work rapidly, consists in placing 200 or 300 gr. of masse-cuite in a piece of cloth of close texture, knotting the corners, and then pressing tightly with both hands. Under this pressure the mother liquor alone passes through the pores of the cloth, and leaks out on every side; one thus obtains a sufficient amount for tests of the sugar and of the water. The sugar was tested by polarisation, and the water by dessication on pumice stone previously washed with H_2SO_4, and calcined. At the moment of taking each sample of masse-cuite in order to extract the mother liquor, I noted the temperature. Knowing the temperature, the sugar and the water, and, as a consequence, the purity, I established the relation of the sugar to water.

$$R = \frac{S}{W}$$

for the temperature T and the purity P.

After each analysis of mother liquor, I maintained the masse-cuite in the crystalliser at the same temperature for two or three hours and collected a fresh sample of mother liquor so as to assure myself that supersaturation had not taken place, a contingency to be always feared, though it is never maintained for long. If the result of the second sample did not entirely agree with that of the first, I tested a third sample at the end of three hours more of stirring at the same temperature. By means of my tables, giving the relation of sugar to water at all temperatures and purities, the chemist will be enabled to calculate in advance the fall in purity of the masse cuite which he proposes to cool, *i.e.*, to know beforehand the exhaustion of the mother liquor saturated at a given temperature in cooling the masse-cuite and departing from a certain purity, by the following formula:—

$$\frac{T -}{T} = \frac{100\ (P - X)}{P\ (100 - X)}$$

where

T = Relation of sugar to water corresponding to the temperature at commencement of cooling.

t = Relation of sugar to water corresponding to the temperature at termination of cooling.

P = Quotient of purity of mother liquor at commencement of cooling.

X = Quotient of purity of mother liquor at termination of cooling.

Example.—Take a masse cuite saturated at 85° at commencement, of which the mother liquor has a purity of 68, and let it be cooled to 40°. Knowing the data, we can calculate in advance the final purity of the mother liquor cooled down to 40°; in other words, we can ascertain beforehand the exhaustion of the masse-cuite runnings, If we take 60 as the purity of the mother liquor:—

$$T = 85^\circ,\ P = 68,\ \text{table gives } 4{\cdot}77;$$
$$t = 40^\circ,\ p = 60,\ \quad ,,\quad ,,\quad 3{\cdot}15.$$

From these we solve the following equation:—

$$\frac{4{\cdot}77 - 3{\cdot}15}{4{\cdot}77} = \frac{100\ (68 - X)}{68\ (100 - X)}$$

from which we find $X = 58{\cdot}36$.

the quotient of purity of the mother liquor at the termination of cooling will thus be 58·36.

In knowing the quotient of purity of the exhausted runnings, we can easily calculate in advance the yield of the masse-cuite in sugar crystals by the following formula:—

$$X = \frac{100\ S\ (P - p)}{P\ (100 - p)}$$

where

X = Yield in crystallised sugar per 100 litres of masse-cuite.
S = Contents in sugar ,, ,, ,,
p = Quotient of purity of mother liquor or centrifugal runnings.
P = ,, ,, masse-cuite.

In practice the results entirely agree with the above calculations.

But apart from the principal factor in crystallisation, which is the solubility of sugar in water, it often happens that the crystallisation is impeded, in certain cases, by a too great viscosity arising from supersaturation of mother liquors, especially at low temperatures (about 40°), and notably when cooling is too hurried. The effect of this viscosity, as well as of the supersaturation, is greatly lessened by the presence of crystals, which induce or excite crystallisation. As a consequence, it is well to carry out the cooling on saturated syrups, containing as many crystals as possible, and to prolong it just to the point where the relation of sugar to water corresponds to the figures given in the adjoining tables.—(*Bulletin de l'Assoc. de Chimistes.*)

TABLE GIVING THE RELATION OF SUGAR TO WATER ACCORDING TO THE QUOTIENTS OF PURITY AND THE TEMPERATURES. (FOR THE PRODUCTS OF BEET SUGAR WORKS.)

QUOTIENT OF PURITY.	TEMPERATURES.												
	95°	90°	85°	80°	75°	70°	65°	60°	55°	50°	45°	40°	35°
100 .. (after Herzfeld)	4·48	4·15	3·85	3·62	3·40	3·20	3·03	2·86	2·73	2·60	2·49	2·38	2·28
99	4·48	4·15	3·85	3·62	3·40	3·20	3·03	2·86	2·73	2·60	2·49	2·38	2·28
98	4·49	4·16	3·86	3·63	3·41	3·20	3·03	2·87	2·73	2·60	2·49	2·38	2·29
97	4·49	4·16	3·86	3·63	3·41	3·21	3·05	2·88	2·75	2·61	2·49	2·38	2·29
96	4·50	4·17	3·87	3·64	3·42	3·22	3·06	2·89	2·76	2·62	2·50	2·39	2·30
95	4·51	4·18	3·88	3·65	3·43	3·22	3·06	2·89	2·76	2·63	2·51	2·39	2·31
94	4·53	4·20	3·92	3·67	3·46	3·24	3·09	2·91	2·77	2·63	2·52	2·40	2·31
93	4·55	4·22	3·92	3·68	3·46	3·25	3·09	2·91	2·77	2·64	2·53	2·42	2·33
92	4·57	4·23	3·93	3·70	3·47	3·26	3·09	2·92	2·78	2·65	2·54	2·42	2·33
91	4·59	4·25	3·95	3·71	3·48	3·28	3·10	2·93	2·10	2·66	2·55	2·43	2·34
90	4·61	4·27	3·97	3·73	3·49	3·29	3·12	2·94	2·81	2·68	2·56	2·45	2·34
89	4·63	4·29	3·99	3·75	3·51	3·31	3·15	2·96	2·83	2·70	2·58	2·46	2·36
88	4·68	4·33	4·02	3·78	3·55	3·33	3·16	2·98	2·85	2·71	2·60	2·48	2·38
87	4·71	4·36	4·05	3·80	3·5	3·36	3·18	3·00	2·87	2·73	2·61	2·50	2·39
86	4·75	4·40	4·09	3·83	3·60	3·39	3·21	3·02	2·89	2·75	2·63	2·52	2·41
85	4·77	4·4	4·10	3·85	3·62	3·41	3·22	3·04	2·91	2·77	2·65	2·53	2·43
84	4·81	4·46	4·13	3·89	3·65	3·44	3·25	3·07	2·93	2·79	2·67	2·55	2·45

83	4·85	4·49	4·17	3·92	3·68	3·46	3·28	3·10	2·95	2·81	2·69	2·57	2·47
82	4·89	4·53	4·20	3·95	3·71	3·49	3·31	3·12	2·98	2·84	2·72	2·60	2·49
81	4·92	4·57	4·24	3·99	3·74	3·54	3·34	3·15	3·01	2·86	2·74	2·62	2·51
80	4·97	4·60	4·27	4·01	3·77	3·55	3·36	3·17	3·03	2·88	2·76	2·64	2·53
79	5·01	4·64	4·31	4·0	3·80	3·58	3·39	3·18	3·05	2·91	2·78	2·66	2·55
78	5·06	4·68	4·35	4·09	3·84	3·61	3·42	3·23	3·08	2·92	2·81	2·68	2·57
77	5·10	4·72	4·37	4·13	3·88	3·64	3·45	3·26	3·12	2·94	2·82	2·70	2·59
76	5·15	4·77	4·42	4·16	3·91	3·68	3·48	3·28	3·13	2·99	2·86	2·73	2·62
75	5·19	4·82	4·46	4·20	3·94	3·71	3·51	3·31	3·15	3·01	2·89	2·75	2·64
74	5·24	4·85	4·50	4·23	3·97	3·74	3·54	3·34	3·19	3·04	2·91	2·78	2·66
73	5·29	4·90	4·55	4·28	4·02	3·78	3·58	3·38	3·22	3·07	2·94	2·81	2·69
72	5·34	4·95	4·59	4·32	4·05	3·82	3·61	3·41	3·25	3·10	2·97	2·84	2·72
71	5·39	5·00	4·63	5·36	4·09	3·85	3·65	3·44	3·28	3·13	3·00	2·86	2·74
70	5·44	5·04	4·68	4·40	4·13	3·89	3·68	3·47	3·31	3·16	3·02	2·89	2·77
69	5·49	5·09	4·72	4·44	4·17	3·92	3·71	3·50	3·34	3·19	3·05	2·92	2·79
68	5·55	5·14	4·77	4·48	4·21	3·96	3·75	3·54	3·38	3·22	3 08	2·94	2·82
67	5·60	5·18	4·81	4·52	4·25	4·00	3·78	3·57	3·41	3·25	3·11	2·97	2·85
66	5·65	5·23	4·85	4·56	4·29	4·03	3·82	3·60	3·44	3·28	3·14	3·00	2·87
65	5·70	5·28	4·90	4·60	4·32	4·07	3·85	3·64	3·47	3·30	3·16	3·02	2·90
64	5·74	5·32	4·93	4·64	4·36	4·10	3·88	3·66	3·50	3·33	3·19	3·05	2·92
63	5·79	5·36	4·97	4·68	4·39	4·13	3·91	3·69	3·52	3·36	3·21	3·07	2·94
62	5·84	5·41	5·02	4·72	4·43	4·17	3·95	3·72	3·55	3·39	3·24	3·10	2·97
61	5·89	5·45	5·06	4·76	4·47	4·20	3·98	3·76	3·58	3·41	3·27	3·12	2·99
60	5·94	5·50	5·10	4·80	4·50	4·24	4·01	8·79	3·61	3·44	3·30	3·15	3·02
59	5·98	5·54	5·14	4·83	4·54	4·27	4·05	3·82	3·65	3·47	3·32	3·18	3·04
58	6·63	5·59	5·18	4·87	4·58	4·31	4·08	3·85	3·68	3·50	3·35	3·20	3·07

A LECTURE ON THE WEST INDIES.

On the 25th of October, a lecture on the West Indies was given by Mr. Wallwyn P. B. Shepheard, M.A., to the members of the Working Men's College. Mr. J. G. Ritchie presided, and introduced the lecturer, and Mr. Algernon E. Aspinall. Mr. Shepheard stated that he deemed it an honour to address the students of a college which was founded by Frederick Denison Maurice. The West Indies were an integral portion of the Empire, and included colonies acquired by settlement and conquest. The islands were inhabited by the Charaibes when Columbus discovered them. These inhabitants judging from their language were of an oriental origin; recently Mr. Hesketh Bell, in a report on the Carib Settlements in Dominica, expressed an opinion that they were of Mongolian origin. The lecturer explained the difference in constitution, laws, and legislative powers between colonies acquired by settlement and those by conquest. The economic relation of the West Indies to England was regarded by John Stuart Mill, as of a home, and not a foreign, character, all their surplus produce becoming an addition to the wealth of England.

As regards bounties, they were the badges of inferiority. If beet sugars were equal to, or better than, cane sugars, why had it never been able to compete on its own merits with cane sugar. Beet sugar was started by protection and, in spite of every improvement in its manufacture, a complete circuit of protection by import duties and export bounties was still found supporting it. The exact effect of this arbitrary interference with the natural course of production was the substitution of beet sugar,—the inferior; for cane sugar—the superior:—the land and labour of the Continent, for the land and labour of the West Indies! Thus had the natural development and utility to England of her West Indian Colonies been arrested and kept in abeyance by the Continental bounty system. He need hardly remind the students that "Free Trade" meant "No Protection." In conclusion, the lecturer expressed a hope that the history of the West Indies would be studied by the students, as there was much in that history of the highest interest to thinkers on economic and constitutional questions.

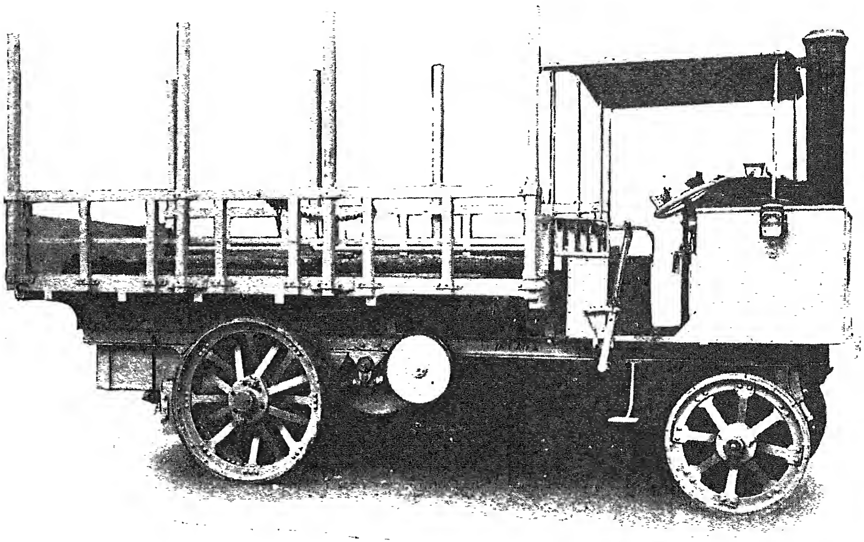
Mr. Shepheard mentioned that his friend, Mr. Algernon Aspinall, who had recently been travelling in the West Indies, had kindly consented to exhibit a most interesting collection of photo-slides. Mr. Aspinall then gave a very graphic and interesting comment on the various views as the operator threw them on the screen. Mr. Ritchie, in thanking Mr. Shepheard and Mr. Aspinall for the lecture, alluded to the interesting fact that, if the original inhabitants of the West Indies came from the East, he had, as an Indian official, often witnessed the departure for the West Indies of the coolies who migrated there to find work and wages.

STEAM WAGONS FOR CANE TRANSPORT.

The charge is often laid at the door of our British Colonial sugar industry that the methods of transporting canes from field to factory are in general still very primitive, bullock or mule wagons being the most commonly used. In Hawaii, as can be seen in the interesting article at present appearing in our columns on recent practice in the design, construction, and operation of raw cane sugar factories in the Hawaiian Islands, narrow gauge railways are laid to the furtherest bounds of the cane fields on which cars loaded with cane can travel. This method has the one disadvantage of all railway systems that their radius of action is confined to such general localities in a plantation as it is convenient to lay rails to, and where the railway does not go, the cars cannot go either; where the cars cannot reach their destined freight, the latter must be carried to the cars. This involves two independent transport actions. It is therefore obvious that a vehicle having as nearly as possible the mechanical efficiency of a railway, and yet capable of reaching any portion of a cane growing area for loading up, possesses great advantages, and these latter should include a considerable saving in time and labour. Such a vehicle we believe to exist, and at any rate its trial so far has proved a success. It must be admitted that its adoption was forced in the first place by unforeseen deprivation of the existing means of haulage, viz., mule transport, but the experiment having once been made, we think the verdict on a well known brand of soap "since then we have used no other" will be repeated here.

But to go into details; an epidemic amongst the mules in Mauritius resulted in such difficulty in getting the cane transported to the factories, that the plantation owners were forced to resort to mechanical traction. Instead of adopting existing methods they decided to go in for steam wagons, or lurries as they are generally called in England, and an order for these was placed with one or two English manufacturers. One of the latter firms, the Straker Steam Vehicle Co. of London, have favoured us with some particulars with regard to the wagons they recently shipped to the above order, and on another page will be found an illustration of one of these machines.

The body is constructed with opened panelled sides, fitted with removable stanchions so as to enable sufficient bulk of cane to be got on board to make up the five ton load. The frame is carried on the two axles by what is known as the three point support principle, which provides for a central pivot in front so as to allow of the front axle rocking independently of the back one. The H.P. installed is in the neighbourhood of 40 I.H.P., the engine being of the open type and the terminal drive by means of a specially constructed compound chain.



THE STRAKER FIVE TON STEAM WAGON FOR CANE TRANSPORT.

The back wheels are 3 ft. 6 in. in diameter and 9 in. on the face. The steaming radius of one tank full of water is approximately 18 miles. With this machine a maximum speed on the level of eight miles an hour can be attained, which gives for working purposes, including stops, an average speed of from five to six miles per hour. It will ascend gradients up to one in six with full load. The fuel consumption is an exceptionally low one, being well under one ton of coke per week.

Since their arrival these machines have given every satisfaction, and have proved the most reliable of any transport vehicles sent to that part of the world. We think that there is a great opening for this class of mechanical transport wagon.

MAURITIUS.

Writing on December 24th, one of our correspondents states:—

"A few estates are on the point of finishing their crops, but the great majority will continue well into the new year. The whole crop is estimated to be about 140,000 tons, but owing to the late finish a considerable portion will appear in the crop of 1903 and the output for 1902 will appear smaller than it actually is. Heavy rains have fallen during the month of December, and have materially added to the difficulties of transport, besides causing a considerable decrease in the sugar content of the cane still left to harvest.

"Very few cases of 'surrah' are now reported, very possibly because so little live stock is left alive; in all it is estimated that ten thousand (10,000) head of stock have died since the outbreak in June, 1902.

"The Imperial Government have consented to a loan of three million (3,000,000) rupees to planters, repayable in two years, for the purpose of providing mechanical means of transport of the cane; the supersession of animal transport will be one of the great improvements in recent years tending towards economy in production, but at the same time planters will lose a large quantity of valuable stable manure which is, in Mauritius, very carefully preserved and applied; its place will have to be taken by the importation of artificial manures.

"At the time of writing the market is fairly firm. Buyers are offering rupees 8·75 per 50 kilos. for first jet, and rupees 8·00 per 50 kilos. for second jet; sellers are asking rupees 9·00 and rupees 8·25 respectively."

There are a number of sugar estates in Portuguese East Africa, either financed by English capital or belonging to English people, and they appear to be doing well. The overseers and pan-boilers come chiefly from Demerara.

ESTIMATION OF STOCKS OF SUGAR AVAILABLE IN SEPTEMBER, 1903.

M. F. Sachs, writing in the *Sucrerie Belge*, proceeds to give his estimate of the quantity of sugar that will be available in the world's market on the 1st of September next, *providing the consumption does not increase in the meanwhile.*

The stocks of sugar in hand on the 1st December, 1902 (as compared with 1901) are given after F. O. Licht as follows:—

Stocks of sugar (calculated in tons of raw).

	1st December, 1902.	1st December, 1901.
Germany	1,042,137	1,047,058
Hamburg	150,510	97,413
Austria	600,000	605,000
France	726,156	541,289
Belgium	170,457	104,453
Holland	88,248	94,126
Great Britain	113,470	79,230
In transport to Europe	20,255	7,323
United States	184,000	133,453
Cuba	63,502	30,037
In transport to U.S.A.	29,727	13,873
Total	3,188,462	2,755,255

Being 433,207 tons more than in the previous year.

But on the other hand the sugar available between 1st December, 1902, and 1st September, 1903, will be considerably less than that of the same period in 1901-2. Here are the figures:—

Production from 1st December to 1st September (in tons raw).

	1902-3.	1901-2.
Germany	441,200	809,503
Austria-Hungary	313,800	426,600
France	149,560	352,533
Belgium	14,644	67,620
Holland	14,200	53,200
	933,404	1,710,456

showing a decrease of 777,052 tons as compared with 1901-2.

The total stocks available next September should therefore be, in tons raw:—

	1902-3.	1901-2.
Total stocks on December 1st	3,188,462	2,755,255
Production from December 1st to September 1st in Europe	933,404	1,710,456
	4,121,866	4,465,711

or a decrease of 343,845 tons.

There remain Russia and the less important countries, as well as the colonies. These we know to be as follows :—

Production of	1902-3. Metric tons.		1901-2. Metric tons.
Russia	1,184,240	..	1,076,250
Sweden	73,098	..	127,020
Denmark	38,477	..	58,132
	1,295,815		1,261,402

being an increase of 34,413 tons.

For cane sugar we find the following discordant figures :—

Estimate of	1902-3.		1901-2.		Difference.
Licht	3,555,000	..	3,437,605	+	117,395
Prager Zuckermarkt ..	3,428,000	..	3,435,000	—	12,000
Willett & Gray.. ..	3,721,000	.	3,869,516	—	148,516
			Mean ..	—	12,707

Now the world's total stocks of sugar on 1st September, 1902, reached 1,808,380 tons. Therefore, if we suppose there will be no increase in consumption as compared with the previous year, the available stocks on September 1st, 1903, should be :—

$$1,808,380 - 343,845 + 34,413 - 12,707 = 1,486,241 \text{ tons}$$

(calculated in raw).

M. Sachs writes in conclusion :—"It may nevertheless be remarked that the calculation we made with regard to the stocks of 1st September, 1902, while fixed by us at 2,360,200 tons, only came out in the end at 1,808,380 tons. This was accounted for by a considerable increase in the consumption, thanks to the big fall in the price of sugar. Without venturing to hope for so great an increase in consumption this year, we believe however that the stocks of sugar on the 1st September, 1903, will attain in any case to the figure of 1,486,241 tons as calculated above."

				Metric Tons.
Stocks on	1st	September,	1898..	1,023,339
,,	,,	,,	1899	820,140
,,	,,	,,	1900..	534,720
,,	,,	,,	1901.... ..	936,690
,,	,,	,,	1902.. . ..	1,808,380

The cane farming system in vogue in Trinidad is making considerable and constant progress. At a meeting recently held in the island it was reported that there were over 9,000 farmers producing sugar cane for sale to the central factories. The amount paid for cane came to nearly $350,000, which gave an average of $40 to each man.

THE CANE SUGAR MOVEMENT.

Since the Colonial and Indian Exhibition, repeated efforts have been made to stimulate the popularity of cane sugars.

In 1886 the members of the West Indian Section of that Exhibition secured the co-operation of the refreshment contractors in placing cane sugar prominently before the public. In 1890 the Cane Sugar Union was formed for the purpose of collecting funds by a trade rate on sugar imports, to be applied in advertising cane sugars. The Trustees were most successful in securing, through their organising agent, Mr. Walter K. Taunton, the friendly co-operation of a large number of grocers in London and Provincial centres, and in Scotland. In 1900 the West Indian and British Guiana Sugar Planters' Trust was constituted to carry on the work of the Cane Sugar Union in a modified form. The funds subscribed were not, in the opinion of the Trustees, sufficient to start advertising with, and were returned to the donors, who applied them in taking up shares in the Monocane Sugar Company, so as to carry on the cane sugar movement on business lines. The difficulty experienced by non-trading bodies like the Cane Sugar Union and the West Indian and British Guiana Sugar Planters' Trust was the legal inability to hold any trade mark. Consequently the only protection against fraudulent imitations of cane sugars sold under erroneous trade descriptions was the prosecution of offenders by the public authorities under the Merchandise Marks Act, or the Food and Drugs Act. The Monocane Sugar Company, Limited, was the outcome of the cane sugar movement, hitherto conducted by non-trading bodies. This company being a trading body can hold trade marks, and thus guarantee the identity of the cane sugars they place before the public. The Directors are Sir Nevile Lubbock, K.C.M.G., Mr. W. P. B. Shepheard, Mr. T. J. Wilkinson, Mr. Rutherford, and Mr. Edward R. Davson. The objects of the company, by its articles of association, are to stimulate, promote, and specialise the demand for the cane sugars of the British West Indies and British Guiana. The shareholders must be personally interested in the cane sugar production of the West Indies, as owners, mortgagees, or merchant consignees.

The sugars are packed into sealed packages bearing the registered trade marks of the company. This effective guarantee secures both buyers and sellers against all difficulties arising from false trade descriptions. In this connection we must not omit to mention the names of Messrs. James Philip & Co. and Messrs. Davison & Newman, who have done and are doing so much to popularise the cane sugar and other products of the British West Indies.

RUSSIAN SUGAR IN THE UNITED STATES.

The following decision of the United States Supreme Court with regard to the question of countervailing Russian bountied sugar will be of considerable importance to the sugar world. We take the text from Messrs. Willett & Gray's Circular:—

RUSSIAN SUGARS.

U. S. Supreme Court Decision.

The United States Supreme Court, at Washington, D.C., decided the Russian sugar case on 5th inst., in effect that Russia indirectly pays a bounty on sugar exported, and, therefore, that sugar imported into the United States from Russia is subject to the assessment of countervailing duty equal to the bounty, according to the Tariff Law in force. This decision supports the position taken by Great Britain and will probably have an influence on Germany, Austria and France in completing the ratification of the Brussels Convention. The quantity of Russian sugars imported into the United States has been small since the countervailing duty has been assessed.

The following statements were agreed upon by the attorneys in the case when it was before the Board of U. S. General appraisers:

"I. The Russian Government estimates the total production and the total consumption of sugar, and the total amount which may be put upon the market at the normal excise of R. 1·75 per pood is definitely fixed at the total amount required for consumption. This is known as free sugar.

"II. The first 60,000 poods produced by each factory is free sugar. The balance of the production is divided into free sugar, obligatory reserve and free surplus or free reserve.

"III. The amount of free sugar in each factory is proportioned to its total production, as the estimated consumption is to the total production of the country. This percentage is fixed by the Government according to the estimates of production and consumption.

"IV. Under the Russian law, therefore, all sugar is divided in the three following classes:

(a) "Free sugar," which consists of a certain quantity of sugar which the Russian Government permits a factory or refinery to sell for home consumption under an excise tax of 1·75 rubles per pood.

(b) "An Obligatory or Indivertible Reserve," of sugar, which consists of a certain quantity kept at each factory or refinery by order of the Government, and which may not be sold or removed without the special permission of the Government.

(c) "Free Reserve or Free Surplus," which consists of such sugar as is manufactured over and above the quantity of "free sugar" and "obligatory or indivertible reserve." This sugar cannot be sold for home consumption, except upon payment of the regular tax of 1·75 rubles and an additional tax of 1·75 rubles, or 3·50 rubles in all.

"And the Russian Government fixes and determines the following:

(a) The total quantity of sugar required for home consumption.

(b) The quantity of "free sugar" allowed to each factory and this "obligatory reserve" which each factory or refinery shall keep on hand.

(c) "The maximum price at which sugar may be sold for domestic consumption.

"V. That the sugar which is imported in this case, and which is covered by this protest, consists of 'free sugar,' as above defined, and would have been subject to an excise tax of 1·75 rubles per pood if sold in Russia.

"VI. That, upon the exportation of said sugar from Russia, the Russian Government, under its laws and regulations, released said sugar from said tax of 1·75 rubles, either by a refund of the tax or a cancellation of indebtedness, or otherwise.

"VII. That in addition to remitting said excise tax the Government issued to the exporter a certificate certifying that he had exported such a quantity of so called free sugar.

"That the said certificates have a substantial market value and are transferable, and that the price thereof is usually determined by the difference existing at the time between the price obtainable for the sugar on the home market and the price obtainable abroad.

"VIII. That said certificates are sold to and used by sugar manufacturers or refiners who are thereby enabled to transfer from their 'free reserve' or 'free surplus' to their 'free sugar' an amount of sugar equal to the amount shown by said certificates to have been exported, which amount may then be sold for domestic consumption on paying the ordinary tax of 1·75 rubles per pood (to which free sugar is regularly subject), instead of a tax of 3·50 per pood.

"IX. That the import duty into Russia is 3 rubles per pood."

Justice Brown handed down the opinion of the Supreme Court and, in discussing the effect of the certificates, he said: "In practice the market value of these certificates must vary according to the demand and supply, but the theory underlying the transactions is always this, that the exporter shall suffer no loss because he has exported his free sugar instead of selling it in the home market. It is practically admitted in this case that a bounty equal to the value of these certificates is paid by the Russian Government, and the main argument of the petitioner is addressed to the proposition that this bounty is paid, not upon exportation, but upon production. The answer to this is that every bounty upon exportation must to a certain extent operate as a bounty upon production, since nothing can be exported which is not produced, and hence a bounty upon exportation by creating a foreign demand stimulates an increased production to the extent of such demand. Consequently, a bounty upon production operates to a certain extent as a bounty upon exportation, since it opens to the manufacturer a foreign market for his merchandise produced in excess of the demand at home. Where regulations exempt sugar exported from excise taxation altogether, we think they clearly fall within the definition of an indirect bounty upon exportation."

OBITUARY.

We regret to have to chronicle the death of Lord Pirbright (better known as Baron Henry de Worms), which took place last month in London. He was a son of Solomon Benedict de Worms, hereditary baron of the Austrian Empire, and was born in London in 1840. His maternal grandfather was a West Indian merchant, and the latter's fortune was indirectly inherited by Lord Pirbright; this fact may have partly accounted for the interest he took in the West Indies. He was much associated with the attempts during the past twenty-five years to secure the abolition of the sugar bounty system, and in this connection we cannot do better than quote the *Times* summary of this aspect of his labours:—

. . . . In the same year (1888) he was raised to the Privy Council and named with the then Prime Minister as one of the plenipotentiaries of this country for the purpose of the International Conference on Sugar Bounties. Baron Henry de Worms prepared the way for the conference by several visits to foreign capitals. He presided at the conference in London, and with Lord Salisbury signed the Abolition Treaty for Great Britain. In his speech on the termination of the conference Baron Henry de Worms, as president, laid stress upon the fact that the conference had confirmed unequivocally and without any reserve on the part of the representative of any nation their entire concurrence in the principle of the abolition of bounties. But economical and political influences prevented the convention thus negotiated from ever coming into force. The trade of the West Indies continued to languish, and the governors of the several Colonies transmitted many representations. Lord Pirbright himself, who had in 1895, on the return of his party to power, been raised to the peerage, wrote and agitated. An article by him in the *National Review* in 1897 was entitled "The Ruin of the West Indies." On December 22, 1896, Mr. Chamberlain appointed General Sir H. W. Norman, Sir Edward Grey, M.P., and Sir David Barbour, Commissioners to visit the West Indies, and upon their report a conference at Brussels was held which resulted in the convention of March 5, 1902. But there were important differences between the convention of London and that of Brussels. Lord Pirbright recently in our columns drew attention to the subject, and expressed the opinion that the Brussels Convention ought not to be ratified by Great Britain. "Our sugar-growing colonies," he observed, "could not be benefited by the acceptance of a convention which, ostensibly for the purpose of protecting the interests of their staple industry, really confers special advantages on the bounty-giving Powers, while denying to Great Britain the right to grant any special benefits to her own possessions." He maintained that the omission from the convention of the provision protecting the signatory Powers against reprisals under the most-favoured-nation clause exposed this country to the dangers attendant upon the denunciation of commercial treaties and the consequent grave losses to our export trade.

BARBADOS SUGAR.

The reviving taste for the old-fashioned cane sugar of the West Indies is becoming a marked feature in the trade; and as this taste or fashion develops it will tend to mitigate, by inducing larger imports of Barbados and other natural cane sugars, the inconvenience so long felt by the public through the scarcity over here of the old-fashioned and once popular sugar of Barbados and the West Indies. This sugar, made in the old-fashioned way, and consequently retaining the natural sweetness and flavour of the sugar cane was the sugar referred to by Addison.

"The Fruits of Portugal," writes Addison in the *Spectator*, "are sweetened by the products of Barbados," and Pepys, in his diary, speaks of the arrival of a cargo of this sugar as a present for the King. Even the insect world take to this soft, sweet sugar, for the bee masters are ordering it for their bees. But what is more important is to observe that the public back their taste for this "most sugary of of all sugars" by paying, at the present time, a higher price for Barbados soft moist sugars than for the finest-looking crushed sugars of France and Germany. Should this turn of taste continue, Barbados may be able to snap her fingers at beet sugar and its bounties.—(From the *Echo*.)

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. Thompson, C.E., F.C.S., M.I.M.E., Chartered Patent Agent, 6, Lord Street, Liverpool; and 322, High Holborn, London.

ENGLISH.—Applications.

28186. G. Deutsch, London. *Improvements in apparatus for whitening sugar in centrifugal machines by means of steam.* 20th December, 1902.

Abridgments.

17175. H. Passburg, Moskau, Russia. *Improvements relating to the treatment of refined sugar.* 2nd August, 1902. This invention has for its object an improved process for treating refined sugar mass, which consists in cooling the sugar mass to zero in moulds having the shape or form of loaves, plates, or lumps.

17178. H. Passburg, Moskau, Russia. *Improvements in and relating to the covering and drying of sugar in moulds.* 2nd August, 1902. This improved process consists in the moulds being secured to a rotating tube so that they hang from the said tube or rest upon the same. The said tube is connected to a suction pump: the juice serving as covering material is sucked from troughs located under the

moulds, and upon the completion of the covering, hot air is drawn in by the same pump, and the drying process thereby effected without removing the moulds from their place.

GERMAN.—ABRIDGMENTS.

133095. Dr. HERMANN CLAASSEN, Dormagen. *A process for the easy separation of sugar and syrup, or rather molasses from the masse-cuite, more particularly bi-product masse-cuite.* 1st November, 1901. In centrifuging the masse-cuite, saturated or almost saturated sugar solution or molasses, warmed or cold, is introduced simultaneously with the masse-cuite into the centrifugal. The syrup still adhering to the crystals is thus at once washed away by the molasses, and any existing crystal flour is prevented forming a tough skin in combination with the mother liquor, and a normal loose raw sugar is produced from a masse-cuite which would otherwise be centrifugalled with difficulty.

133584. PAUL RASSMUS, Magdeburg. *A process and apparatus for watching the crystallisation in vacuum boiling down pans, and the like.* 12th October, 1901. In this process any drawing of samples is unnecessary. The inside of the spy-glass of the vacuum boiling down pan is approached by a plate, which either forms itself a reflector or is transparent, and lies in front of a reflector mirror adapted to be illuminated from the outside or from the inside, in order to enclose between the spy-glass and the plate a thin layer of the substance to be crystallised, for observation. By means of a stuffing-box over the spy-glass a tube is arranged in such a way as to be adjustable and revoluble, which tube is bent inwardly, and carries at its enlarged end the transparent plate, an incandescent lamp, the supply wires of which are carried through the tube, and a reflector mirror, and said tube is approached to the spy-glass with these fittings. A movable magnifying glass is arranged in front of the spy-glass to allow of microscopic inspection of the sample layer.

134915. Dr. HERMANN CLAASSEN, Dormagen, Rhine Province. *A method for regulating the super-saturation in the crystallisation of impure sugar solutions.* 9th January, 1901. The super-saturation of the mother liquor from which the crystals are formed under agitation, and cooling is regulated by the addition of water in such a way that the quotient of super-saturation remains constant between 1·25 and 1·02, according to the purity of the sugar solutions. This addition of water is commenced even in the vacuum pan before or after the formation of the masse-cuite.

134335. W. H. UHLAND, Leipzig-Gohlis. *An apparatus for the constant separation of starchy raw material.* 6th June, 1901. (Patent of addition to Patent No. 126203, of the 28th February, 1899.) The starch washing apparatus described in the principal patent is in its lower part formed as a settling apparatus. The opening for dis-

charging the starch milk from the washing apparatus connects, by means of a hopper and a pipe attached thereto and widening downwards (under which pipe a cone is arranged), with a vessel provided with an overflow, which vessel during the working of the apparatus is always filled with liquid. The starch which is deposited by sinking down through the liquid is constantly discharged in a concentrated condition through a lower funnel-shaped bottom, whilst the liquid portion constantly flows away by the overflow; this latter lies at such a height that the starchy substance is always obtained floating in the settling or washing compartment.

135315. Metallwaaren-Fabrik vorm. Fr. Zickerick, Wolfenbüttel. *A process and apparatus for mashing masse-cuite and like crystallisable substances.* 25th July, 1901. In the crystallisation of masse-cuite in movement, the thin syrup accumulating in the upper part of the masse is carried off, and introduced under pressure in a distributed condition into the lower part of the heavier masse. For this object a pressure pump is connected with the mashing vessel, which pump is connected both with the upper and with the under part of the vessel in such a way that the liquid conveyed to it from the upper part of the vessel is again forced into the lower part, by means of a multiple branched pipe, in several places simultaneously through narrow slots.

135359. Josef Janacek, Ránsko, Bohemia. *A means for adjusting and fixing the front plate in shredding knife boxes.* 19th May, 1901. The front plate is pivotally mounted on pins in the knife-box. The covering of the front plate and its fixing is effected by means of screws, in the grooved heads of which two studs located on the front plate engage, so that when the screws are turned the front plate is also turned on its pins, and retained in the position given to it when the turning is completed.

Copies of all published specifications with their drawings in these lists can be obtained from W. P. Thompson & Co., 6, Lord Street, Liverpool, at One Shilling a copy for English or American Patents, and Two Shillings for German. In ordering please give number and date.

WEEKLY STATEMENT OF COMPARATIVE

For the Fifty-two weeks compared

	German Beetroot 88 o/o Prompt, free on board.						French Crystals. No. 3. c. f. i.			West India. Good Brown.			Java afloat. No. 15 and 16.		
	1902.		1901.		1900.		1902.	1901.	1900.	1902.	1901.	1900.	1902.	1901.	1900.
Jan. 3..	6/6½	6/5¾	9/0¼	9/1	9/2	9/2½	8/4½	10/6¾	10/6¾	—	—	—	8/9	12/-	11/3
10..	6/5¾	6/5	9/1	9/3¾	9/2½	9/5½	8/2¼	10/8¼	10/6¾	—	—	—	8/6	12/-	11/3
17..	6/5	6/7½	9/3¾	9/3¼	9/5½	9/7¼	8/5¼	10/7½	10/6¾	—	—	—	8/3	12/-	11/3
24..	6/7½	6/7½	9/3¼	9/1¼	9/7¼	9/6¾	8/5¼	10/8¼	11/-	—	—	—	8/3	11/10½	11/4½
31..	6/7½	6/8¾	9/1¼	9/2½	9/6¾	9/10	8/7½	10/8¼	11/-	—	—	—	8/3	11/10½	11/4½
Feb. 7..	6/8¾	6/9	9/2½	9/3½	9/10	10/0½	8/7½	11/-	11/3¾	—	—	—	8/4½	11/10½	12/-
14..	6/9	6/8½	9/3½	9/3¼	10/0½	10/-	8/7½	10/10½	11/3¾	—	—	—	8/7½	11/9	12/1½
21..	6/8½	6/10	9/3¼	9/2½	10/-	9/9	8/9¾	10/9¾	11/1½	—	—	—	8/7½	11/9	12/1½
28..	6/10	6/8	9/2½	9/2¼	9/9	9/9¼	8/7½	11/-	11/1½	—	—	—	8/7½	11/7½	12/-
March 7.	6/8	6/5½	9/2¼	9/0½	9/9¼	9/10½	8/3	10/11¼	11/2¼	—	—	—	8/7½	11/7½	12/3
14..	6/5½	6/3½	9/0½	8/11½	9/10½	10/0¼	8/2¼	11/-	11/3¾	—	—	—	8/4½	11/7½	12/3
21..	6/3½	6/3¼	8/11½	9/0	10/0¼	10/1¾	8/3¾	11/1½	11/6¾	—	—	—	8/-	11/7½	12/3
28..	6/3¼	6/6¼	9/-	8/11½	10/1¾	10/1¼	8/7½	11/-	11/6¾	—	—	—	8/3	11/7½	12/4½
April 4..	6/6¾	6/5½	8/11½	8/11	10/1¼	10/3½	8/6	11/1½	11/11¼	—	—	—	8/3	11/7½	12/6
11..	6/5½	6/5½	8/11	8/10½	10/3½	10/5	8/5¼	11/3¾	12/2¼	—	—	—	8/-	11/10½	12/9
18..	6/5½	7/2¾	8/10½	8/10	10/5	10/4	8/3	11/-	12/-	—	—	—	8/-	11/10½	12/9
25..	6/2¾	6/1	8/10	9/0½	10/4	10/5	8/1½	10/8¼	12/1	—	—	—	7/9	11/10½	12/9
May 2..	6/1	6/3	9/0½	9/5	10/5	10/7¾	8/4½	11/7½	12/4½	—	—	—	7/9	11/10½	12/9
9..	6/3	6/4¼	9/5	9/6	10/7¾	10/5½	8/7½	Nom.	12/-	—	—	—	7/9	11/9	12/9
16..	6/4¼	6/4	9/6	9/7	10/5½	10/6½	8/6	Nom.	12/3	—	—	—	7/9	11/9	12/10½
23..	6/4	6/2	9/7	9/6¼	10/6½	10/8¾	8/5¼	Nom.	12/4½	—	—	—	7/9	11/7½	13/-
30..	6/2	6/2¾	9/6¼	9/6	10/8¾	10/8½	8/5¼	Nom.	12/4½	—	—	—	7/9	11/7½	13/-
June 6..	6/2¾	6/2½	9/6	9/4	10/8½	10/11	8/5¼	Nom.	12/6	—	—	—	7/9	11/6	13/1½
13..	6/2½	6/3½	9/4	9/2¾	10/11	10/10	8/6	Nom.	12/5¼	—	—	—	7/9	11/6	13/-
20..	6/3½	6/2	9/2¾	9/2¾	10/10	11/0¼	8/3¾	Nom.	12/7½	—	—	—	7/6	11/4½	13/-
27..	6/2	6/-	9/2¾	9/3¾	11/0¼	11/3¼	8/2¼	Nom.	13/3	—	—	—	7/6	11/4½	13/-
July 4..	6/2	*5/11½	9/3¾	9/3¼	11/3¼	11/5	8/0¾	Nom.	14/-	—	—	—	7/6	11/4½	13/-
11..	5/11½	5/11¾	9/3¼	9/1¾	11/5	11/7¼	8/1½	Nom.	14/-	—	—	—	7/9	11/4½	13/-
18..	5/11¾	5/11½	9/1¾	9/6¾	11/7¼	12/1¼	8/3	Nom.	14/-	—	—	—	7/9	11/4½	13/3
25..	5/11½	6/0½	9/6¾	9/4	12/1¼	12/4¼	8/6	Nom.	14/-	—	—	—	7/9	11/4½	13/3
Aug. 1..	6/10½	6/-	9/4	9/3	12/4¼	11/5	8/6	Nom.	14/-	—	—	—	7/9	11/4½	13/6
8..	6/-	6/-	9/3	8/10½	11/5	11/9	8/6	Nom.	13/9	—	—	—	7/9	11/-	13/6
15..	6/-	6/1	8/10¼	8/4¼	11/9	11/9¼	8/5¼	Nom.	13/-	—	—	—	7/9	10/10½	13/3
22..	6/1½	6/1¼	8/4¼	8/3	11/9¼	11/11¼	8/0¾	Nom.	12/9¾	—	—	—	7/9	10/7½	12/9
29..	6/1¾	6/-	8/3	8/1¼	11/11¼	12/4	8/0¾	Nom.	12/9¾	—	—	—	7/9	10/4½	12/9
Sept. 5..	6/-	5/11	8/1¼	8/0½	12/4	11/6½	8/-	Nom.	12/7½	—	—	—	7/9	10/3	12/4½
12..	5/11	5/11½	8/0½	7/9¼	11/6½	11/8¾	8/1½	Nom.	12/6¾	—	—	—	7/9	10/3	12/9
19..	5/11½	6/1	7/9¼	7/7	11/8¾	12/-	8/3	Nom.	12/9	—	—	—	7/9	10/-	13/-
26..	6/1	6/3¼	7/7	7/5	12/-	10/11½	8/4½	9/3¾	12/-	—	—	—	7/9	10/-	13/-
Oct. 3..	6/3¼	7/2	7/5	7/7¾	10/11½	9/11½	9/9	9/3	11/6	—	—	—	8/-	10/-	13/1½
10..	7/2	7/1	7/7¾	7/7	9/11½	9/9	9/9	9/1½	11/6	—	—	—	8/-	9/6	13/3
17..	7/1	7/2½	7/7	7/8¼	9/9	9/8½	9/9	9/3	11/-	—	—	—	8/6	9/3	13/-
24..	7/2½	7/7	7/8¼	7/4¼	9/8½	9/8	10/3	8/9	11/-	—	—	—	9/-	9/3	12/10½
31..	7/7	7/6	7/4¼	7/1¾	9/8	9/5½	—	8/6¾	11/-	—	—	—	9/3	9/-	12/10½
Nov. 7..	7/6	7/5½	7/1¾	7/2¾	9/5½	9/5	—	8/6¾	10/11¼	—	—	—	9/3	9/-	12/10½
14..	7/5½	7/6½	7/2¾	7/3¼	9/5	9/7¾	—	9/-	11/0¾	—	—	—	9/-	9/-	12/10½
21..	7/6½	7/10	7/3¾	7/4¼	9/7¾	9/8½	—	9/-	11/0¾	—	—	—	9/-	8/9	12/10½
28..	7/10	7/11	7/4¼	7/3	9/8½	9/9	—	8/10½	11/0¾	—	—	—	9/-	8/9	12/10½
Dec. 5..	7/11	8/2¾	7/3	7/1	9/9	9/8	—	8/10½	11/0¾	—	—	—	9/3	8/9	12/9
12..	8/2¾	8/4¾	7/1	7/1½	9/8	9/2¾	—	8/10½	10/9	—	—	—	9/3	8/9	12/6
19..	8/4¾	8/2	7/1½	6/10¼	9/2¾	9/1¼	—	8/9	10/6¾	—	—	—	9/3	8/9	12/3
26..	8/2	8/1¾	6/10¼	6/6½	9/1¼	9/0¼	—	8/6¾	10/4½	—	—	—	9/3	8/9	12/3

* 5/10½ on July 2nd.

PRICES OF RAW AND REFINED SUGAR,

with those of the two previous years.

	Tate's Cubes. No. 1.			Tate's Cubes. No. 2.			First Marks German Granulated f. o. b.			Say's Cubes f. o. b.			German & Austrian † Cubes f. o. b.		
	1902.	1901.	1900.	1902.	1901.	1900.	1902.	1901.	1900.	1902.	1901.	1900.	1902.	1901.	1900.
Jan. 3..	17/6	16/–	15/9	16/9	14/9	15/3	8/4½	11/–	11/0¾	11/–	13/–	13/3	10/4½	12/10½	12/10½
10..	17/6	16/–	15/9	16/9	14/9	15/3	8/5¼	11/3	11/3¾	11/–	13/–	13/–	10/4½	13/–	12/10½
17..	18/3	16/–	15/9	17/6	14/9	15/3	8/6	11/3	11/4½	11/–	13/–	13/–	10/1½	12/10½	13/1½
24..	18/–	15/9	15/9	17/6	14/6	15/3	8/6	11/1½	11/3	11/–	13/–	13/3	10/1½	12/9	13/1½
31..	18/–	15/9	15/6	17/6	14/6	15/–	8/8¼	11/2¼	11/1½	11/–	13/–	13/3	10/1½	12/9	13/1½
Feb. 7..	17/9	15/9	15/6	17/3	14/6	14/9	8/8½	11/3¾	11/3	11/–	13/–	13/3	10/1½	12/9	13/3
14..	17/6	15/9	15/6	17/–	14/6	14/9	8/8¼	11/6	11/3¾	11/–	13/–	13/3	10/1½	12/9	13/3
21..	17/6	15/9	15/6	17/–	14/6	14/9	8/7½	11/6	11/1½	11/–	13/–	13/1½	10/1½	12/9	13/1½
28..	17/6	16/–	15/4½	16/9	14/9	14/7½	8/5½	11/6	11/1½	11/3	13/–	13/1½	10/1½	12/9	13/–
March 7..	17/6	16/–	15/4½	16/9	14/9	14/7½	8/–	11/1½	11/3¾	11/3	13/–	13/1½	10/–	12/9	13/1½
14..	17/6	16/3	15/4½	16/6	15/–	14/7½	7/10½	11/–	11/5¼	10/9	13/–	13/1½	10/–	12/7½	13/1½
21..	17/6	17/–	15/6	16/6	15/9	14/7½	7/11¼	11/1½	11/7½	10/9	13/–	13/4½	9/10½	12/10½	13/3
28..	17/6	16/6	15/6	16/6	15/3	14/7½	8/4½	11/0¾	11/7½	11/–	13/–	13/4½	10/–	12/10½	13/1½
April 4..	17/6	17/–	15/7½	16/6	15/9	14/7½	8/2¼	11/–	11/9¾	10/6	13/–	13/6	9/10½	12/10½	13/3
11..	18/6	17/6	15/10½	17/–	16/3	14/10½	8/–	10/9	11/11¼	10/6	13/–	13/9	9/9	12/10½	13/7½
18..	17/6	20/–	16/–	16/6	18/3	15/–	7/9¾	10/6	11/11¼	10/6	13/–	14/–	9/6	12/10½	13/10
25..	17/–	20/–	15/10½	16/–	18/3	14/10½	7/7½	10/7½	12/–	10/6	12/9	14/–	9/7½	12/9	13/10½
May 2..	17/–	19/9	16/–	16/–	18/–	15/–	7/9	10/10½	12/2¼	10/3	12/9	14/–	9/9	12/6	14/–
9..	17/–	19/9	16/–	16/–	18/–	15/–	7/9¾	10/10½	12/0¾	10/3	13/–	14/–	9/9	12/7½	14/–
16..	17/–	19/6	16/–	16/–	18/–	15/–	7/9¾	11/–	12/2¼	10/3	13/–	14/–	9/7½	12/7½	14/–
23..	17/–	19/6	16/–	16/–	18/–	15/–	7/9	11/1½	12/3¾	10/3	13/–	14/–	9/6	12/10½	13/10½
30..	17/–	19/6	16/–	16/–	18/–	15/–	7/8¼	11/1½	12/4½	10/3	13/–	14/–	9/6	12/10½	13/10½
June 6..	17/–	19/6	16/1½	16/–	18/–	15/1½	7/7½	11/0¾	12/6	10/3	13/–	14/–	9/4½	12/10½	14/–
13..	17/–	19/6	16/–	16/–	18/–	15/–	7/9	11/0¾	12/6	10/3	13/–	14/–	9/6	12/10½	14/–
20..	17/–	19/6	16/–	16/	18/–	15/–	7/7½	11/0¾	12/6¾	10/–	13/–	14/–	9/4½	12/10½	14/–
27..	17/–	19/6	16/3	16/–	18/–	15/3	7/6	11/0¾	12/9	10/–	13/–	14/1½	9/4½	12/10½	14/1½
July 4..	17/–	19/3	16/4½	16/–	18/–	15/4½	7/4½	11/0	12/10½	10/–	13/–	14/3	9/4½	12/10½	14/4½
11..	17/–	19/–	16/4½	16/–	18/–	15/4½	7/4½	10/11¼	13/0¾	10/–	12/9	14/3	9/4½	12/10½	14/4½
18..	17/–	19/–	17/6	16/–	18/–	16/6	*7/4½	11/0¾	13/6	10/–	12/9	15/–	9/3	12/10½	15/–
25..	17/–	19/–	17/9	16/–	18/–	16/9	7/6	11/–	13/9¾	10/–	12/9	15/3	9/3	12/10½	15/6
Aug. 1..	17/–	19/–	17/6	16/–	18/–	16/6	7/4½	11/–	13/2¼	10/–	12/9	15/3	9/3	12/9	15/3
8..	17/–	19/–	17/3	16/–	18/–	16/3	7/5¼	11/–	13/6	10/–	12/9	15/–	9/4½	12/9	15/–
15..	17/–	19/–	17/3	16/–	18/–	16/3	7/6¾	10/9	13/7½	10/–	12/9	15/–	9/4½	12/9	15/–
22..	17/–	18/9	17/–	16/–	17/9	16/–	7/6¾	10/7½	13/6¾	10/–	12/9	14/9	9/4½	12/4½	15/–
29..	17/–	18/9	17/–	16/–	17/9	16/–	7/6¾	10/6	13/6	10/–	12/9	14/9	9/3	12/3	14/10½
Sept. 5..	16/9	18/6	16/9	15/9	17/6	15/9	7/6	10/4½	13/6	10/–	12/3	14/4½	9/3	12/3	14/10½
12..	16/6	18/6	16/6	15/6	17/6	15/9	7/6	10/2¼	13/7½	10/–	12/3	14/4½	9/3	12/3	14/9½
19..	16/6	18/6	16/9	15/6	17/6	—	7/7½	9/9	13/10½	10/–	12/3	14/4½	9/3	11/10½	14/9
26..	16/6	18/3	16/9	15/6	17/6	16/3	7/9¾	9/6	13/8¼	10/3	11/9	14/4½	Nom.	11/9½	14/10½
Oct. 3..	17/–	18/3	16/9	16/–	17/6	16/3	8/3¾	9/5¼	13/3	10/9	11/9	13/7½	—	11/9½	13/3
10..	17/–	18/3	16/9	16/–	17/6	—	8/2¼	9/4½	12/–	10/9	11/9	15/–	—	11/3	13/3
17..	17/–	18/–	16/9	16/–	17/3	16/3	8/3¾	9/2¼	11/5¼	10/7½	11/9	15/–	10/3	11/1½	13/–
24..	17/3	18/–	16/9	16/6	17/3	—	8/8¼	8/7½	11/3¾	11/–	11/9	14/9	10/6	10/10½	13/6
31..	17/3	17/9	16/9	16/6	17/–	16/3	8/6¾	8/3¾	11/1½	11/–	11/6	14/9	10/6	10/9	13/6
Nov. 7..	17/3	17/6	16/9	16/6	16/9	16/3	8/7½	8/3¾	11/–	11/–	11/3	14/9	10/6	10/6	13/6
14..	17/3	17/6	16/9	16/6	16/9	16/3	8/8¼	8/7½	11/1½	11/–	11/3	14/9	10/6	10/7½	13/6
21..	17/9	17/9	16/9	16/9	17/3	16/–	9/0¾	8/11¼	11/1½	11/6	11/3	14/9	10/10½	10/9	13/6
28..	18/–	18/–	16/6	17/–	17/3	15/6	9/2¼	8/10½	11/1½	11/9	11/3	13/9	11/–	10/9	13/4½
Dec. 5..	18/1½	18/–	16/6	17/1½	17/3	15/6	9/7½	8/10½	11/1½	11/9	11/3	13/9	11/4½	10/7½	13/4½
12..	18/3	17/9	16/6	17/3	17/–	15/3	9/9¾	8/10½	10/9	12/–	11/3	13/9	11/6	10/7½	13/1½
19..	18/3	17/9	16/3	17/3	17/–	15/–	9/6	8/8¼	10/9¾	12/–	11/3	13/6	11/6	10/6	13/–
26..	18/3	17/9	16/3	17/3	17/–	15/–	9/6	8/5¼	10/9¾	12/–	11/3	13/6	11/6	10/6	12/10½

* 7/3¾ on July 18. † Basis average Hansa FKL FMS.

H. H. HANCOCK & Co., 39, Mincing Lane, London, E.C.

IMPORTS AND EXPORTS OF SUGAR (UNITED KINGDOM),

To end of December, 1901 and 1902.

IMPORTS.

Raw Sugars.	Quantities.		Values.	
	1901.	1902.	1901.	1902.
	Cwts.	Cwts.	£	£
Germany	4,402,269	6,570,337	1,922,258	2,316,837
Holland	310,511	336,765	126,981	110,317
Belgium	1,728,305	668,740	761,412	242,774
France	3,810,923	1,706,418	1,882,338	658,378
Austria-Hungary	72,372	334,859	30,272	126,342
Java	208,975	....	86,771	....
Philippine Islands	50,465	49,936	22,792	14,880
Peru	96,373	159,834	42,005	57,182
Brazil	341,783	577,786	155,410	191,376
Argentine Republic	666,344	806,644	307,678	304,812
Mauritius	436,571	323,733	203,488	111,398
British East Indies	175,374	202,816	78,855	73,952
Br. W. Indies, Guiana, &c.	929,366	1,279,485	679,117	757,043
Other Countries	157,512	160,841	78,647	62,616
Total Raw Sugars	13,387,143	13,178,194	6,378,024	5,027,907
Refined Sugars.				
Germany	13,240,442	13,485,232	8,008,891	7,009,349
Holland	2,608,387	2,388,866	1,683,115	1,372,472
Belgium	441,564	150,064	272,952	87,071
France	4,952,641	2,270,925	2,974,007	1,196,188
Other Countries	13,812	94,734	9,869	43,386
Total Refined Sugars	21,256,846	18,389,821	12,948,834	9,708,466
Molasses	1,709,674	1,382,764	365,329	269,383
Total Imports	36,353,663	32,950,779	19,629,187	15,005,746

EXPORTS.

British Refined Sugars.	Cwts.	Cwts.	£	£
Sweden and Norway	42,856	45,231	29,680	24,432
Denmark	97,102	138,729	60,367	70,051
Holland	53,662	72,188	31,269	37,842
Belgium	9,283	10,190	5,524	5,072
Portugal, Azores, &c.	23,791	8,700	13,558	4,361
Italy	4,627	24,116	2,659	11,328
Other Countries	324,988	417,449	207,704	246,868
	556,309	716,603	350,761	399,954
Foreign & Colonial Sugars.				
Refined and Candy	70,415	44,235	49,352	28,678
Unrefined	122,895	91,337	74,875	45,073
Molasses	50,151	1,955	15,945	733
Total Exports	799,770	854,130	490,933	474,438

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1903. Tons.		1902. Tons.
Total Receipts, 1st Jan. to Jan. 15th....	33,824	..	39,547
Receipts of Refined ,, ,, ,, ..	50	..	909
Deliveries ,, ,, ,, ..	33,824	..	42,980
Consumption (4 Ports, Exports deducted) since 1st January	53,930	..	46,729
Importers' Stocks (4 Ports) Jan. 14th ..	53,930	..	46,729
Total Stocks, Jan. 28th	129,000	..	102,817
Stocks in Cuba, ,, ,, ...	101,000	..	102,471
	1902.		1901.
Total Consumption for twelve months ..	2,566,108	..	2,372,316

CUBA.

Statement of Exports and Stocks of Sugar, 1901 and 1902.

(Tons of 2,240lbs.)	1901. Tons.		1902. Tons.
Exports	560,700	..	761,077
Stocks	37,079	..	68,727
	597,779	..	829,804
Local Consumption (12 months)..	38,600	..	40,250
	636,379		870,054
Stock on 1st January (old crop)	523	..	19,873
Receipts at Ports up to 31st November ..	635,856	..	850,181

Joaquin Guma.

Havana, 30th November, 1902.

UNITED KINGDOM.

Statement of Twelve Months' Imports, Exports, and Consumption for Three Years.

From *Produce Markets' Review.*

	1902. Tons.	1901. Tons.	1900. Tons.
Stock	114,894 ..	65,549 ..	57,815
Imports, Raw Sugar, Jan. 1st to Dec. 31st.	658,909 ..	669,357 ..	661,746
,, Refined, Jan. 1st to Dec. 31st ..	919,491 ..	1,062,842 ..	962,409
,, Molasses, Jan. 1st to Dec. 31st...	69,138 ..	85,484 ..	67,397
	1,762,432	1,883,232	1,749,367
Stock, in 4 chief Ports	119,605 ..	114,894 ..	65,549
	1,642,827	1,768,338	1,683,818
Exports (Foreign, and British Refined) ..	42,609 ..	37,480 ..	52,798
Apparent Consumption for Twelve months.	1,600,218	1,730,858	1,631,020

Stocks of Sugar in Europe at uneven dates, January 1st to 28th, compared with previous Years.

In thousands of tons, to the nearest thousand.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	Total 1903.
130	1394	829	654	303	3312

	1902.		1901.		1900.		1899.
Totals	3482	..	2796	..	2597	..	2574

Twelve Months' Consumption of Sugar in Europe for Three Years, ending December 31st, in thousands of tons.

Great Britain.	Germany	France.	Austria.	Holland, Belgium, &c.	Total 1902.	Total 1901.	Total. 1900.
1704	840	604	396	528	4079	4111	4128

Estimated Crop of Beetroot Sugar on the Continent of Europe for the current Campaign, compared with the actual crop of the three previous Campaigns.

(From Licht's Monthly Circular.)

	1902-1903. Tons.	1901-1902. Tons.	1900-1901. Tons.	1899-1900. Tons.
Germany	1,730,000	..2,299,408	..1,984,186	..1,798,631
Austria	1,050,000	..1,302,038	..1,094,043	..1,108,007
France	900,000	..1,183,420	..1,170,332	.. 977,850
Russia	1,225,000	..1,110,000	.. 918,838	.. 905,737
Belgium	240,000	.. 350,000	.. 393,119	.. 302,865
Holland	120,000	.. 203,172	.. 178,081	.. 171,029
Other Countries.	355,000	.. 400,000	.. 367,919	.. 253,929
	5,620,000	6,843,038	6,046,518	5,518,048

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Blyth Bros. & Co., Mauritius, report shipments of sugar from August 1st to 9th January as 67,781 tons, against 68,515 tons in the corresponding period of 1901-1902.

The Brussels Convention.

As we anticipated, there was a reference in the King's Speech at the opening of Parliament to the Sugar Convention Bill which the Government propose to introduce during the Session. This gave an opportunity to Sir William Harcourt, as leader of the opposition, to ask several questions. His chief desire was to know, firstly, what effect the Convention would have on our treaties possessing a most-favoured-nation clause; and, secondly, how would the Convention effect our self-governing colonies, some of which give bounties. Mr. Balfour's reply was short and decisive. He declared that the Convention, in the opinion of the Government, did not interfere with the clause at all. He might have added that the continuance of bounties on the other hand is an infraction of that clause, since it does not ensure to all foreign nations equality of treatment in our markets as regards sugar. With regard to the second question, Mr. Balfour's reply was very definite. The Government had never wavered in their view from the beginning of the negotiations, and they made it an emphatic condition before ratifying the Convention—viz., that in no circumstances would they consent to penalize sugar from our own colonies. The other parties had been told of these conditions, but up to the last day for ratification had not made any official protest, and

therefore our condition of ratification would stand. It was suggested that when the question was submitted to the Commission of the Brussels Convention, we should be overruled by a hostile majority; but Mr. Balfour asserted that there was no possibility of that contingency occurring, because the Government did not intend to allow that question to be submitted to the Commission, and had so stated to the powers concerned. The latter would therefore be helpless, as they could not very well coerce us to do that which we had given them fair warning we did not intend to do. But after all, they know that the question is almost entirely an academic one, since no sugar in receipt of a bounty is exported from our colonies to this country, and none is likely to be during the duration of the Convention.

An Indian contemporary, discussing the Brussels Convention, expresses the opinion in no unmeasured terms that the Government of India would commit a most serious blunder if it consented to be a party to it. The result of any such agreement would be to place Indian sugar, like British sugar, under the control of a European Commission sitting at Brussels, who would decide at what rate any given sugar was to be taxed; but whereas Great Britain would be represented on this Commission, India would have no voice whatever in its deliberations. Under the circumstances, the latter was far better off in her present state, where she could countervail as she thought fit for the protection of her internal sugar trade. But there is little question of the Indian Government giving their adherence to the Convention; they prefer to retain their fiscal independence.

Revised American Countervailing Duties on Austrian Sugar.

A recent U.S.A. Treasury decision fixes the Austro-Hnngarian export sugar bounties as follows:—On sugar under 99·3 per cent. and not less than 90 per cent. Pol., 2·21 kr. per 100 kg. (equal to ·203 c. per lb.). On sugar of at least 99·3 per cent. Pol., 3·18 kr. per 100 kg. (equal to ·293 c. per lb.). Naturally the countervailing duties are estimated on the same basis; the reduction from former rates is ·024 c. on raws, and ·034 c. on refined sugars.

Mechanical Tillage.

At the first meeting of the year of the British Guiana *Royal Agricultural and Commercial Society* the new President, Mr. F. I. Scard, in the course of his address, discussed the question of mechanical tillage. He stated at the outset that as far back as 1844 horse ploughs had been experimented with, but the stiff nature of the soil and the heavy character of the ploughs had proved too much for animal traction. In the seventies an attempt was made to employ steam ploughs, but it failed; too many difficulties were thereby

introduced, one being the weight of the heavy traction engines employed. But now matters were somewhat different; comparatively light oil motors could easily be transferred from place to place, and would take the place of steam engines. The speaker knew the arguments advanced against mechanical tillage, but in spite of that, he considered it would have to be adopted in the near future to some extent.

Greenock Refineries for Sale.

For the third year in succession we have occasion to call attention to the fact that two Greenock refineries are in the market. It is not surprising that so far no would-be purchasers have come forward, considering the stagnation in the British refining trade which has existed so long. But with the abolition of bounties, a very different state of affairs will shortly come into existence, and British refining will gradually recover some if not all of its one-time prosperity. It will therefore be strange if these refineries continue abandoned much longer. All particulars with regard to them can be obtained from Messrs. McArthur and Orkney, City Buildings, Greenock, whose advertisements regarding the sale appear on pages xvii. and xviii. of this journal.

We are requested to announce that the International Congress for Applied Chemistry will meet in Berlin, on Tuesday, June 2nd, for one week. The organization of the V. Section (sugar) is in the hands of a committee which includes, amongst others, Dr. Claassen, of Dormagen; Prof. Dr. Herzfeld, of Berlin, and Prof. Dr. Lippmann, of Halle-on-Saale. Papers will be submitted by Messrs. Abraham (Kiew), Aulard (Genappe), Claassen (Dormagen), Herzfeld (Berlin), von Lippmann (Halle), Sachs (Brussels), Saillard (Paris), Wiley (Washington), and others. Particulars with regard to their nature will be given in the full programme to be issued at a later date. Besides the reading of papers and their discussion, it is proposed to organize several excursions in the vicinity of Berlin, when a beet seed producing establishment, and a sugar factory and refinery will be visited and inspected. All information required can be obtained on application to Herrn Prof. Dr. Herzfeld, Invalidenstrasse 42, Portal VIII., Berlin, N., and needless to say a hearty invitation is given to all interested in the sugar industry to be present.

The Barbados sugar crop of 1903 has been estimated to yield 40,000 hogsheads. This is about one-third below the average. The canes are low and dry, but the sucrose content is considered to be good.

A REPLY TO THE OPPOSITION TO THE BRUSSELS CONVENTION.

The National Liberal Federation seems to be about to define in concentrated form the objections to the Sugar Convention. The Executive Committee, at its meeting on the 4th February (see report in *Daily Chronicle* of 6th February), decided to submit the following resolution to the General Committee on the 27th of February:—

"That this Committee protests against the ratification of the Brussels Sugar Convention, which, whilst depriving the United Kingdom of the advantages of cheap sugar, confers no substantial benefit upon the West Indies, places our fiscal arrangements under the control of foreign nations, and constitutes a dangerous reversal of the trade policy of the country."

This is a concise statement of four clearly defined objections, but without any proof of their truth.

With equal conciseness, and in as few words as possible, it can be shown that these four objections are unfounded, and are, in fact, exactly the reverse of the truth.

1. The Convention will not "deprive the United Kingdom of the advantages of cheap sugar;" on the contrary, it will, by restoring free and open competition, secure those advantages and avert the inevitable result of bounties, which by closing the door to competition while artificially stimulating production in the bounty-fed area, bring about an alternation of excessive supplies and temporary cheapness, with reduced production and high prices. Natural production, being discouraged by this process, is gradually squeezed out and the bounty-fed sources of supply obtain command of the market, and eventually a monopoly. The experience of more than twenty years proves that this is a correct and accurate statement of the result of the sugar bounties. Bounty-fed sugar constitutes now two-thirds of the visible supply of the world, and 92 per cent. of the sugar consumed in the United Kingdom. Even the bounty-fed area is gradually being squeezed by the larger bounties of Germany and Austria so that we are within measurable distance of having only two countries to rely upon for our supply instead of the twenty we have now. The price has fluctuated enormously with the constant variations between markets glutted with bounty-fed sugar on the one hand, and the inevitable consequence of reduced supplies and a great rise in price on the other. A further disturbing cause is found in the constantly increasing dependence of the consumer on the bounty-fed area of production, and therefore on the climatic accidents which may affect that area. The price of sugar has fluctuated between 6s. and 28s. per cwt., and the average has

been considerably above the present cost of production, not only of beet but also of cane sugar. Therefore, with free competition, it may be confidently asserted that the average price will be less, not more, than that which has prevailed during the period of bounties.

2. The Convention *will* confer a "substantial benefit on the West Indies." At present, when the price of sugar falls to 6s., which is 2s. to 3s. per cwt. below the cost of production, the producer of West Indian sugar has to pay the difference out of his own pocket. He is, in fact, in exactly the same position as if his produce were taxed to that amount when entering our markets while bounty-fed sugar was admitted free. The subsequent rise in price, which is the necessary result of such an artificial state of things, is no compensation to him for his former losses, which must lead to much distress, to great discouragement, and, in many cases, to actual ruin and the abandonment of estates. The average price has been higher than it would be now if there were no bounties, but the natural producer has been so discouraged and so utterly unable to obtain the credit necessary to carry on his industry that it is perfectly clear that open competition a fair field and no favour, a strict adherence to the principle of the survival of the fittest, will be to him a very great and most "substantial benefit." That the abolition of bounties would be of no benefit to the West Indies, is contrary to the opinion of the Royal Commission who specially examined the question, is contrary to the opinion of the Colonial Office, of the Governors of the West Indian Sugar Colonies, of all those engaged in the sugar industry in those colonies, and of the sugar experts in Mincing Lane. It is simply an assertion unsupported by any evidence.

3. The Convention does not "place our fiscal arrangements under the control of foreign nations." On the contrary, that is exactly what bounties do. They have exactly the same effect as if we protected the European sugar by admitting it free, while charging a duty on our own colonial sugar. The European producer is permitted to be protected in British markets. Another similar result of bounties is to frustrate the intention of the most-favoured-nation clause in our commercial treaties. The object of that clause is to secure that equality of conditions in our markets is enjoyed by the produce of the country which has entered into the contract with us. The bounties destroy that equality.

The countries who are parties to the Brussels Convention are to keep a sharp look out by means of an international Commission to see that no bounties are given. If that is called putting our fiscal arrangements under the control of foreign nations it is evidently a very much smaller interference than that which has just been described. But practically it is no interference at all, because it would be difficult to find a more capable board of arbitration on the subject of sugar bounties than a collection of the leading countries

of Europe who have just abolished their bounties, and who will therefore take very good care that no bounties are given in future.

4. The Convention does not "constitute a dangerous reversal of the trade policy of the country." That has been definitely declared by a Committee of the House of Commons, which devoted two years to a careful consideration of the subject, examined and cross-examined eminent witnesses, many of whom held the view enunciated in this resolution, and gave its reasons very clearly for deciding that such a policy as that carried out in the present Convention is quite in accordance with the commercial policy of the country. The majority who came to that conclusion was a large one, and represented both sides of the House. The minority made no reference to the subject in their report. The National Liberal Federation must therefore show that the report of the Select Committee is erroneous before they can make an assertion which the report of that Committee contradicts.

It is astounding and almost incredible that a body of intelligent men should be so easily misled as the Committee of the National Liberal Federation have been in this matter. They advocate artificial and therefore temporary cheapness, the protection of foreign producers in British markets, the shutting of the door to free and open competition, and the practical levying of a differential duty against our own colonies. These are the men who pose as free traders and the apostles of Cobden. They seem to forget that Cobden's only object was that people should have corn "at its natural price, and every source of supply be freely opened, as nature and nature's God intended it to be."

Mr. PLATT-HIGGINS, M.P., ON THE BRUSSELS SUGAR CONVENTION.

Although Manchester is supposed to be a stronghold of the Cobdenites, it is represented in Parliament by men whose breadth of view and power of comprehension is in striking contrast to the characteristics of some of their leading constituents; the latters' views are best shown at the Chamber of Commerce meetings, where from time to time resolutions are passed, condemning any fiscal or commercial schemes which they allege will tamper with their pet but erroneous theory of free trade.

Their mistaken attitude to the Brussels Sugar Convention is a case in point. Possibly Mr. Platt-Higgins had this in mind when recently addressing his constituents, for he dealt with the sugar question more clearly, thoroughly and accurately than any other M.P. yet appears to have done. Dealing with the fallacious argument to which Mr. Harold Cox fondly clings, that what is a loss to

the West Indies is a proportionate gain to us, he stated. "Now he (Mr. Cox) improves on his previous performance, and he asserts that if the disadvantage to the West Indian producer is £5 a ton, the advantage to the British consumer must also be £5 a ton, and consequently the total gain to this country must be £7,500,000 a year. In my view, it neither must be nor is anything of the kind, nor would any man who knows anything about business fall into such a blunder. The President of the Board of Trade stated in the course of the November debate that the German Government gives a direct export bounty of 1s. 2d. per cwt., but that the sugar traders have managed by their cartel or trust system to add 3s. 10d. per cwt., so that their total advantage is 5s. per cwt. He told us also that while it costs the Continental beet sugar maker 8s. 9d. per cwt. to deliver in London, it only costs the West Indian cane sugar maker 8s. 6d., and that there is every probability of reducing this figure of 8s. 6d., but that in consequence of this artificial advantage of 5s. per cwt., the dearer article has almost driven the cheaper article out of the market—surely no man acquainted with business can possibly regard such a state of things with satisfaction. Mr. Cox, of the Cobden Club, apparently believes that the German producer is simple enough to hand over to us the whole of the advantage of 5s. per cwt., or £5 per ton which he has in his pocket, and that this amounts to giving us £7,500,000 a year, but does anyone who knows the ways of the Manchester Exchange believe that when two sellers approach a buyer it is the practice of the seller who has an advantage of 5s. up his sleeve to give the whole of it to the buyer? He knows that his rival cannot sell under 8s. 6d. without being out of pocket, but does he at once offer his wares at 5s. below his own cost and say 3s. 9d.? Not at all. He proceeds to offer at 8s. 5d. Under these circumstances the consumer gets only 4d. of the 5s., the remaining 4s. 8d. being retained by the astute German sugar trader. Present prices are about 8s. f.o.b., Hamburg, or say about 8s. 8d. in London. At these prices the German sugar traders are not giving us any part of their 5s. bounty; and it is all going into the pockets of the German sugar trade. What, then, are we to think of Mr. Cox continuing to mislead us by saying that the bounty system means that other countries are giving us £7,500,000 a year?"

Mr. Platt-Higgins, then pointed out that the real danger now threatening this country was that we might soon find the sugar industry in the hands of a Germany monopoly. Whereas, 50 years ago, cane sugar formed 86% of the world's production, now it had fallen to 33%. And if a proof were wanted that German beet is beginning to monopolize our sugar markets it was shown by the fact that French sugar had been nearly driven away within the last 18 months.

In this connection we adduce a few figures by way of illustration.

IMPORTS OF RAW AND REFINED SUGAR INTO THE UNITED KINGDOM

For Twelve months ending December, 1900, 1901 and 1902.

From Germany.

	1900. Cwts.		1901. Cwts.		1902. Cwts.
Raw	3,212,180	..	4,402,269	..	6,570,337
Refined	11,868,651	..	13,240,442	..	13,485,232
Total	15,080,831		17,642,711		20,055,569

From France.

Raw	4,733,908	..	3,810,923	..	1,706,418
Refined	4,332,939	..	4,952,641	..	2,270,925
Total	9,066,847		8,763,564		3,977,343

These figures show that while in the last 12 months, the German imports have increased by 13·6 per cent., those of France have decreased by no less than 54·6 per cent.

Still more striking are the figures given in the Board of Trade Returns for the month ending January, 1902 and 1903.

	From Germany.				*From France.*		
	1902. Cwts.		1903. Cwts.		1902. Cwts.		1903. Cwts.
Raw	925,577	..	343,740	..	525,799	..	3,852
Refined	2,250,494	..	1,030,672	..	865,167	..	57,692
Total	3,176,071		1,374,412		1,390,966		61,544

In comparing these figures, one must not overlook the fact that the 1902 figures were greatly swelled owing to the attempt made to get in as much sugar into the country as possible before the Budget day, so as to escape the rumoured further taxation.

Austria's contribution, during the month of January, has been as follows:—

	1901. Cwts.		1902. Cwts.		1903. Cwts.
Raw sugar	2,930	..	21,150	..	355,643

It is, therefore, abundantly clear that the two Cartel countries (Germany and Austria-Hungary), are rapidly absorbing all the beet sugar imports into this country, and that France has retired decisively beaten. The Cartel bounty has enabled the German and Austrian manufacturers to undersell their rivals, and as France is their most formidable competitor, they would thereby have successfully surmounted their greatest difficulty, had not the Brussels Convention come to our aid, and robbed them at the eleventh hour, as it were, of the fruits of their victory.

To point to another of Mr. Platt-Higgins' lucid illustrations, there is the case of American lard imported into the United Kingdom. A few years ago the price of this commodity fell to 17s. for refined.

It then ceased to pay to feed pigs at that price, consequently production fell off. An American Trust next got possession of the market, and put up the price to 58s. 6d. A similar possibility awaits us as regards sugar if the bounty system is not now abolished; and though "the confectioners, jam makers, and those interested in the importation of beet sugar, like the silversmiths of Ephesus, are crying out that their craft is in danger," it is clear a far greater and more certain danger awaits them if they are allowed to have their own way, and get the Convention defeated.

THE PROTECTION OF CANE-CUTTINGS DURING TRANSPORT.

By Albert Howard, M.A., F.L.S.,
Late Mycologist to the Imperial Department of Agriculture for the West Indies.

Since the discovery of the fact that the sugar-cane bears fertile seed, a considerable amount of attention has been devoted to the raising and testing of new seedling canes in Java, the West Indies, and elsewhere. In consequence, a large number of new canes have found their way into cultivation in these localities, some of which appear to be more disease-resisting than the older varieties. It would appear to be desirable for the Experiment Stations of each sugar-growing country to test, not only its own seedlings, but also, those produced in other parts of the world. Further, in the breeding of new varieties, such desirable canes as the Cheribon of Java, and the wild varieties of India, would be of considerable value, judging from the latest Java results. Possibly, some of the imported canes would give better results than those produced locally. At any rate, the matter would seem worthy of careful trial.

Unfortunately, however, two difficulties have to be reckoned with in attempting to carry out such tests. In the first place, the cane-growing localities are widely separated, and the only practicable means of sending canes from, say, Java to the West Indies would appear to involve the use of a Wardian case and arrangements being made for the watering of the young canes several times on the journey. Such a method involves great expense, and besides, would only be practicable during the summer. In the second place, there would be a danger of introducing new insect and fungoid pests along with the canes. A method, therefore, at once safe, cheap, and expeditious, would seem to be desirable. The preliminary experiments on the subject, referred to in the present paper, are put forward in the hope that they may be of use in the solution of the question.

While engaged in a study of the diseases of the sugar cane in the West Indies during the past three years, I had occasion to pay some

attention to the fungi which destroy cane cuttings soon after they are planted and the methods of prevention applicable thereto. It was found that if the cuttings were dipped in Bordeaux mixture and then tarred at the cut ends, that the ravages of West's "pine apple" disease fungus (*Thielaviopsis ethaceticus*), are greatly lessened.* During these experiments some cane cuttings were left in Bordeaux mixture for a week. When planted, they all grew readily and appeared to have suffered little or no harm from their long immersion in this fungicide.

In order to determine what happens if cuttings are kept in Bordeaux mixture for longer periods, and whether it would be practicable to send cuttings long distances while immersed therein, the following experiment was carried out. One hundred and sixty healthy cuttings, each with three buds, were selected, placed in the fungicide for twelve hours and then allowed to dry. Half of these were then tarred at the cut ends. The cuttings were then made up into four bundles of forty each (twenty of each set being tarred at the ends), and then placed in a barrel of Bordeaux mixture. At the end of the second, fourth, sixth, and eighth week one set of cuttings was taken out, washed for twelve hours in water and then planted. The results are given in the following table:—

Length of time in Bordeaux Mixture.	Tarred.		Untarred.	
	No. of cuttings which grew.	No. of buds which developed.	No. of cuttings which grew.	No. of buds which developed.
14 days ..	19	25	20	27
28 ,, ..	13	20	15	22
42 ,, ..	4	4	5	9
56 ,, ..	2	4	5	8

The rapid falling off in development which took place, when the cuttings had been immersed for more than a month, was apparently due to the fact that the fungicide had penetrated the tissues of the cutting to a great extent and destroyed the buds. That even seven of the forty cuttings which had been in the mixture for eight weeks should have grown is, to say the least, surprising. The result of the experiment indicates that an immersion of more than twenty-eight days is distinctly harmful, while a shorter period does not seem to be attended with much loss of growing power.

*The experiments referred to here were published in the *West Indian Bulletin*, Vol. III., No. 1, 1902, and are noticed in the *International Sugar Journal* of July, 1902, (Vol. IV., p. 363).

It now appeared desirable to find whether cuttings which had been placed in the fungicide for a short time (24 to 48 hours) could be kept in pulverised charcoal, to which a small quantity of powdered copper carbonate had been added to check the development of fungi. As time did not permit of this experiment being tried in the West Indies, a preliminary test, on a small scale, was made at the Botanical Gardens at Cambridge. Ten cuttings from a mature cane, growing in the Lily House, were placed in Bordeaux mixture for 24 hours, and then, after drying, in powdered charcoal, to which had been added a small quantity of copper carbonate. The box containing the cuttings was placed in the tropical pit at the gardens for 63 days, after which the pieces of cane were planted. Although the cuttings had dried very considerably during their stay in the charcoal, four out of the ten developed. It would seem that if the charcoal had been slightly moistened, so as to prevent this drying up, a better result might have been obtained. Perhaps treatment of the charcoal with Bordeaux mixture and then partial drying would have been better. If the charcoal were too moist, growth would take place; if too dry, the cuttings would shrivel. The exact amount of moisture necessary to prevent excessive drying without leading to root development would have to be determined by experiment.

It would appear therefore that this method deserves a trial. If found to be successful, cuttings could be sent from place to place through the post, and the danger of introducing new pests would be reduced to a minimum.

These experiments are put forward, incomplete and inadequate as they are, in the hope that further work on the subject may be undertaken by others, and that a method may ultimately be found by which plant introduction in the case of the sugar-cane may be rendered easier, cheaper, and safer than seems to be the case at present.

The largest of the Demerara Sugar Factories, Plantation Diamond, has recently been introducing more elaborate and up-to-date machinery. Its present plant includes a Bodley-Mallon cane unloader—(costing over £2,000), a Fulton nine-roller mill, which leaves but 42 to 44 % of moisture in the megass, and extracts 90 % sugar; two *Climax* water-tube boilers, each equal to about a thousand horse-power; a new Harvey Triple-effet, and a new 34 ton vacuum pan of Messrs. Fawcett, Preston & Co.'s make. The crop for the season just closed came to 10,200 tons, which represents an average of 2½ tons to the acre.

THE SUGAR INDUSTRY IN QUEENSLAND.

By J. T. Critchell.

The Commonwealth and the Kanaka.

The present moment is opportune for writing an account of the Queensland Sugar Industry, as it is now possible to form a rough idea of how growers are getting on without the assistance of Pacific Islanders for field work. The Kanaka Bill issued in October, 1901, by Sir E. Barton, Premier of the Commonwealth of Australia, took everybody outside politics by surprise, as it was taken for granted that full enquiries would be made before legislation was passed. The large amount of capital invested in sugar growing and making in Queensland (estimated at £7,000,000 to £10,000,000), and the important place the industry occupies in the agricultural and commercial fabric of the State, called for caution and deliberation, but the Federal Government, acting at the instigation of the labour party in Parliament, carried the Kanaka Bill, notwithstanding the strenuous opposition of the Premier of Queensland, the Hon. Robert Philp, who voiced public opinion in Queensland apart from the labour vote. It is, however, necessary to add that at the Federal elections in March 1901, Queensland sent down a largely predominating labour representation, pledged *inter alia* to a "White Australia," including of course Kanaka abolition.

Under the measure South Sea Islanders have to be limited in numbers imported up to 31st December 1903, in March 1904 importation is to cease altogether, and any Islanders in the State on 31st December 1906, must be deported. Five years were thus given to planters to provide substitutes, or give up business, an uncommonly awkward fix for them. In some quarters it is held that this exclusive policy may be modified before the time comes for the removal of the Kanakas, but I don't think there is any good ground for entertaining such hopes, the Colour question being a part of the bed-rock policy of the powerful labour party in Australia. Rightly or wrongly, the dominant class there has made up its mind to keep out all black and yellow races; they say: "We won't run the risk of having racial troubles such as we see in the United States," but, as at the same time they have set their foot down (as firmly as they dare), upon the immigration of whites too, this argument lacks force.

Therefore, the Queensland sugar growers have made up their minds that the Kanaka has to go. There are rather less than 10,000 of these Islanders in the State; half of them are depositors in the Government Savings Bank, £32,000 lying to their credit. Many are married, and their children born in the State, being British subjects, cannot be deported by force in 1906, so the Federal Act will, in some cases, separate parents from children.

Polynesians were first brought to Queensland in 1866, and the recruiting and employment came under State control two years later. The working classes were always bitterly opposed to them, though the Kanakas have only laboured in the field, leaving mill work to whites. In 1884 a Royal Commission was appointed to report on the Kanaka question, and, as the result, the then Premier, Sir Samuel Griffith, initiated legislation excluding Kanaka immigration after 1890. The sugar industry immediately showed signs of decline, no capital could be got for it, and the people of the colony raised such an agitation that Sir Samuel Griffith had to recant. The trade was again legalised, and was conducted quite satisfactorily till the Commonwealth bombshell fell in Queensland in 1901. It may be suggested that what occurred after 1884 may again take place, but there is a great difference; then the voters of Queensland had to decide, now the decision rests with a Parliament drawn from mainly, as to numbers, the large population of Sydney and Melbourne, which, living in temperate climes, 1,000 and 1,500 miles away from the Queensland sugar growing districts, have no knowledge of tropical conditions.

The vessels enlisting Kanakas are licensed by the Government, and a "Government Agent" is on board of each schooner to see that the Islander gets his full rights. The latter is indentured to a planter for three years, and is provided with house-room, food, and clothes, and £7 to £8 a year wages; they are a happy and contented people on the plantations, and a large number decline to take advantage of a return passage at the end of their three years, which the Government offers them. These become "walk about" Kanakas, and re-engage on their own account. The total annual cost of the Kanaka is from £30 to £40.

I have dealt fully with these South Sea Islanders, as the fine Queensland sugar industry has been built up upon their work in the fields, and it is interesting to put the circumstances on record in the columns of this Journal. In arguing that the white man is physically able to labour in the open air, tending the sugar plant in North Queensland in summer time, and able to continue to do so from year to year, as the Kanaka does, the Australian politicians are advancing a contention which is opposed to the logic of fact, as your readers interested in sugar cultivation in other tropical parts of the world know full well. What might with advantage have been done was to establish a "colour line" at the tropic of Capricorn. As things stand, no Asiatic or Pacific alien is permitted to land in Australia; and the productive territories of Northern Australia, which cannot be developed without coloured labour, must therefore lie fallow! I discussed the burning question of the future of Queensland's sugar industry, under the new conditions, during a recent tour in that State, with many people. Mr. A. C. Cowley, M.L.A., one of the

best authorities on Australian tropical agriculture, said:—"As a big thing I fear the industry will become extinct, and I think it is possible that the Colonial Sugar Refining Company will take all its plant to Fiji. No doubt, on a small scale cane sugar will continue to be grown in Queensland by whites."

The New Sugar Regulations.

The duty imposed by the Commonwealth Tariff on cane sugar is £6 a ton, on beet sugar £10. There is an excise of 3/- per cwt., and in order to give a fillip to the employment of white labour in the sugar fields, the Government have issued a set of regulations under which growers can claim rebate for "white-grown cane," that is, cane planted, cultivated, and harvested, by white labour. As the new conditions have so recently been in force, no supervision was exercised over the planting of last season's crop, the regulations were only applied to the sugar fields at March 1st, 1902. The rebate is intended to be £2 per ton of sugar, and the allowance is fixed according to the district and its special average sugar-giving contents of cane, viz.:—Southern district, 10 per cent., 4/-; Central district, 10·83 per cent., 4/4; Northern district, 12·5 per cent., 5/-. The weight of the cane is checked at the mill on delivery, and a rebate note is issued, which on being confirmed by the Customs Officer in the district, is cashed within three days. It was necessary that sugar-growers should register by February 28th, last year, as to whether they intended to employ white labour and claim the bonus under the Regulations. This has been done by planters all over the sugar lands of Queensland, as to part of their estates, so the experiment has been tried, as we on this side are anxiously waiting full particulars. Crushing in Queensland begins in July, and harvesting operations are carried on from July to November, comparatively cool months. This year's experience will be a better guide as to the future than that of the season just over, inasmuch as all rebate sugar will have to be both grown and harvested by white labour.

The *Sugar Journal*, published at Mackay, Queensland, states in its latest issues to hand, that about one-third of the cane grown in its district last year was cut by white men, and the same journal says that it is not likely that the proportion in 1903 will work out more favourably for the theory of those who say that white men can do black men's work. But taking the sugar producing areas of the State as a whole, nothing like one-third of the cane of 1902 was cut by whites; one-seventh may be nearer the mark as an estimate. Taking growers in Queensland as 2,500, we find that about one-third (855) claimed rebate, though such claim did not enforce employment of white men. Judging by the rather incomplete particulars available, white men on contract work – they generally work in gangs—cut about two tons per day per man, at 3/- per ton.

But after all, the main contention of planters is that the difficulty to be feared is not so much that white men cannot do this work, as that it will be impossible to get sufficient numbers of them; if they are going to fully replace Kanakas they will have to come forward to the number of 8,000 to 10,000, and nothing like such figures have been chronicled in 1902. For many years white labour has been employed in a desultory way on the Queensland sugar estates at harvest time, and the objection to it on the part of the owners has been both on account of unreliability and want of effectiveness. In the most southern of the districts, Bundaberg, about latitude 25, there is a greater volume of white labourers available, the out-come of proximity to the capital, Brisbane, and the coolness of the climate. In the North, Chinese, Hindoos, and Malays supplement the Islanders, though these aliens will rapidly fail, as their numbers cannot be recruited under the exclusion policy of the Federal Government.

It is likely enough that the bonus referred to above will be demanded by the contract cutters, and mill hands, in increased wages.

Central Mills.

The sugar planter of former days, who grew his cane and crushed it himself, owning both estates and mills, was pretty well ruined by the state of things induced by Sir Samuel Griffith's Act aforesaid, and by the low market prices for sugar following the development of the bounty-fed article; he could not stand against attack from both within and without, and planters were mostly overwhelmed by these tendencies. The Government which had decreed the abolition of reliable labour saw with dismay the impending extinction of the industry, and realised that it had to come to its assistance in some form or other. So the system of central factories was established, and mills were erected by State-found money; the Sugar Works Guarantee Act of 1893 was passed, under which the Government advanced funds to companies of farmers to erect mills and machinery. The process was for the company to issue debentures which were guaranteed by the Government, which itself cashed them at 5% interest, holding these securities for placing on the market, if desirable. Repayment had to be made in 15 years. Thirteen companies have been registered under this Act, and the figures to 30th June, 1902, may be tabulated:—

	£.
Total advances to 13 central mills	514,600
Interest and redemption paid	90,855
Do. do. unpaid	70,090

Only three of these establishments have a clean sheet as regards payment of interest and redemption; so it will be seen that the central mill in Queensland has not proved financially successful, though it has fostered the industry. Two mills, North Eton and Racecourse, at Mackay, were formed by direct Government grant, before the Act

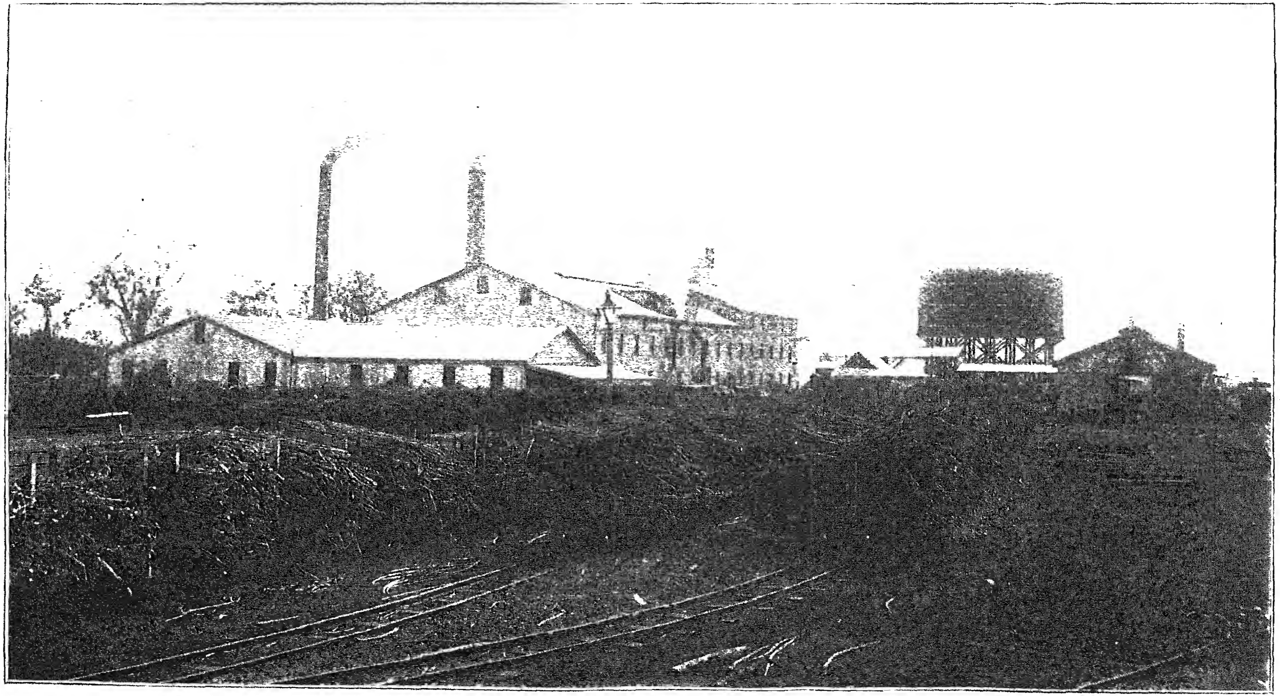
referred to was passed, in order to test the problem of growing cane with white labour.

For the season 1901-2 the following returns were issued, comprising the operations of the 13 mills in question:—Cane crushed, 301,881 tons; average cost of cane, 14s. 6¾d.; sugar manufactured reduced to 88% N.T., 33,112 tons; average cane to sugar, 9·12 tons; average cost manufacture at mill, plus cane purchase, plus f.o.b. expenses (Mossman and Mulgrave Mills), per ton cane, £1 0s. 6d., per ton sugar, £8 19s. 6d.

The number of growers contributing to these 13 mills were 816. The balance sheet shows that all the mills—save one—show a profit as the result of work, varying from £3 3s. 2d. per ton of sugar (Isis Mill) to 1s. 7d. (Prosperpine Mill).

The central mill system is now all but entirely accepted; the land is mortgaged to mills, and the mills to the Government. Farmers cut in July to deliver about 10 tons of cane per day to December.

Apart from these central mills under State subsidy, the system of separating the growing of sugar from the milling, and the establishment of privately owned central mills, has now been in existence for some time, and is the prevailing method under which the bulk of sugar is now produced in Queensland. Many of the large plantations have been cut up and sold in lots to small farmers, who covenant to supply cane at a price fixed according to density. The great corporation which virtually manages the sugar trade in Australia, the Colonial Sugar Refining Company, generally termed, in short, the C.S.R. Co., leases much of its sugar lands to growers who supply the mills with cane. The passing of sugar planting into the hands of peasant proprietors, a system which gradually came about under the central mills, was hailed as a great boon, and in a democratic community like Queensland the change undoubtedly was beneficial. Still, it must be remembered that the plan upon which the mills were founded was that cane for them should be grown entirely by whites, a theory which could not bear the brunt of practice; in every direction it was departed from. Miss Shaw, the special correspondent of the *Times*, who went to Queensland in 1892, sent home some letters to her paper describing the passing of sugar planting from the old order to the new. She was very enthusiastic over the change, and spoke of "small growers and large mill-owners as the basis of future success." The correspondent unearthed a selector on the Herbert River who had cleared 100 acres and had 70 under cane; he was making a net profit of £300 a year,—the difference between income £800 and working expenses £500—the average price for cane at that time was 10s. a ton, standing in the field, and price for cutting and delivering 2s. 6d. A year or two later there were about 1,400 sugar holdings in the colony, comprising 70,000 acres, ranging from 2 to 110 acres—I refer to the small holdings under the Government central mill system. At the



ISIS CENTRAL SUGAR MILL, QUEENSLAND.

time Miss Shaw wrote there were from 400 to 500 farmers engaged in growing cane.

This method of working the industry on a democratic basis was a development of enormous importance, and had the movement been coupled with the realisation of the contention of the working class leaders that white labour was competent for all the field work, the business of making sugar in Queensland would not be in such a parlous state as it is now.

The Mill Manager as Harvester.

But another method of arranging the handling of cane seems imminent, according to the information I received during my visit to the State. Miss Shaw saw democracy supplanting planters. Since her visit the output of sugar has been doubled, though no more coloured labour has been employed than in the days of the planters, a creditable result for central mills and their collateral system of cultivation. Now, however, instead of there being about 500 farmers, there are over 2,500, and keen competition has consequently been introduced, with the consequent necessity of working the cultivating department of the industry on a strictly scientific basis.

It is being found that it is difficult, if not impossible, to get farmers to attend to the all-the-year-round work of cultivation thoroughly, and therefore another change is coming over the scene. Money and brains are taking hold of the work; the methods in vogue for the last 10 years of growing and harvesting cane by farmers possessing limited organising power, brains, and capital, cannot go on, if sugar is to be produced at a profit. The growers do not cultivate their cane all the year round, as they should, and the future of the central mills in the State depends upon good cultivation and smart harvesting. The present state of the farmers growing sugar in Queensland is that they just make a living, being but the feeders of the C.S.R. Co., who will keep them going as long as they can grow cane cheaper than the company itself. The chief fault of the Queensland farmers is that they work their land to death. The idea of the old fashioned manufacturer in Queensland and big owner of estates was to rid himself of trouble in looking after masses of labour, and to stimulate white labour by making the subsidiary co-operative farmers a sort of works overseer. It is now found that when crushing comes, each farmer, bound by contract to supply a certain quantity of cane to a mill per day, employs all his labour on his own fields in harvesting, neglecting to look after cultivation. The new system now coming about is the organisation of labour for harvesting by the mill manager, who says to the farmer, "we will take off your crop at 2s. 3d. or 2s. 6d. a ton." This way of doing business is rapidly extending, and it possesses the advantage of allowing the farmer to devote himself to his farm constantly.

Bounty or no Bounty.

An interesting and apropos question at the present time is this:—Does the assistance rendered to the sugar industry in Queensland by the Government, under the Act described, constitute a bounty on sugar production? Questions have been asked in the House of Commons, and the Ministry does not seem to be very clear on the point. The condition, as your readers know, is that if any British Colony grants bounties on sugar cultivation or manufacture, Great Britain would have to penalise any imports of sugar that may come from that Colony.* The fact that there is not the least likelihood of Queensland exporting sugar here at present does not affect the argument.

In considering the matter, I cannot do better than quote the statement made on the subject by Sir Horace Tozer, Agent-General in London for Queensland, when lecturing at the Royal Colonial Institute on January 17th, 1899.

"It is contended in some quarters that the assistance given by the "State in this industry is equivalent to a bounty. The facts will show "that this is untenable. The cost of the introduction and regulation "of Pacific Island labour is borne by a special fund provided by the "planters. It is true that the State has, in accordance with its "general policy of advances to local bodies, provided the funds for the "purchase and erection of twelve central mills out of the sixty-five "mills at work in the colony, and to the extent of half a million "sterling; but the repayment of principal and interest is secured, not "only by a mortgage over the mill, but over the freeholds of the many "co-operators who own and supply the mill with cane. Under this "credit mobiliser system, all moneys advanced are repaid to the State "as to a private mortgage."

This voices the opinion held generally by men who have thought out the point; they come to the conclusion that the relations between the State and sugar producer is that of lender and borrower—just a commercial position. The State can foreclose if it chooses, in case of unpaid interest; in fact, this has been done in one instance, where the Government put in a manager, much to the benefit of the mill owners, for he made it pay.

Dr. Maxwell.

In considering the present conditions on which sugar production stands in Queensland, leaving statistics and descriptions of districts till later, I must devote a little space to the advent in the colony of Dr. Walter Maxwell, who came from Hawaii, where he was Director and Chief Chemist of the Experiment Stations of the Hawaii Sugar Planters' Association. It was felt in Queensland that the services of a modern sugar expert, well versed in scientific knowledge and possessing experience of sugar growing in other countries, were required. Dr. Maxwell was invited by the Government to investigate

*This question is dealt with on another page.—*Ed. I.S.J.*

the condition of the sugar industry, which work he undertook at the end of 1899. His report deals fully with the more technical and scientific aspects of the subject, state of soils, climates, &c., and he recommended the establishment of Experiment Stations in the sugar growing districts. Dr. Maxwell was appointed Director of Experimental Stations, under special Act of Parliament, in 1900, at a salary of £3,000 a year, his engagement being for five years. His work in the colony has been directed towards the systematising and organisation of the industry on a scientific basis; he analyses soils, recommend manures, and generally gives technical advice to growers. (Dr. Maxwell is fond of quick-acting manure which the cane plant can seize upon.) His special line has been irrigation, which is coming to be accepted in Queensland as the proper means to ensure successful sugar growing. Dr. Maxwell did good work in Honolulu, and it is expected that under his guidance cultivation in Queensland may assume a modern and scientific aspect. The Regulations given above owe their form to the advice tendered by him to the Commonwealth Government. A special levy of one penny per ton of cane (½d. paid by grower, ½d. by mill) is made upon the growers and mill owners towards the cost of Dr. Maxwell's department. In 1901, £4,923, representing one penny per ton on 1,181,522 tons crushed, was received, and supplemented, £ for £, by the State Government, towards the Bureau of Experiment Stations' expenditure, which only amounted to £6,722.

Early Days and Progress.

The first cane produced in Queensland was grown by Captain Louis Hope, on the Logan River, about 1860, and the first sugar manufactured was a parcel of 7 lbs., made as an experiment, *coram populi*, in the Brisbane Botanic Gardens, in 1863 or 1864, by Mr. Buhôt. People then said it was impossible to produce granulated sugar, owing to the climate, and Mr. Buhôt, holding the contrary, rigged up a rough plant, and gave a show. After that the farmers on the little rivers south of Brisbane, cultivated sugar on a small scale, and Mr. Porter constructed a floating sugar mill, called the *Walrus*, which moved from farm to farm. Brisbane, however, is too far south for sugar to be grown commercially, and the start of the industry on business lines took place at Mackay, a coast town, in latitude 21 south; Mr. John Spiller, now living in England, planted the first cane in the Mackay district in 1864. The Alexandra Mill was erected in 1868, and 230 tons of sugar and 148 hogsheads of rum were produced. In the seventies the industry waxed, and by 1879 quite 10,000 tons of sugar were produced by the Mackay mills.

(To be continued.)

THE SUGAR CANE IN EGYPT.

By Walter Tiemann,

Member of the Society of German Sugar Technists and of the Assoc. des Chemistes de Sucreries et Distilleries, Paris.

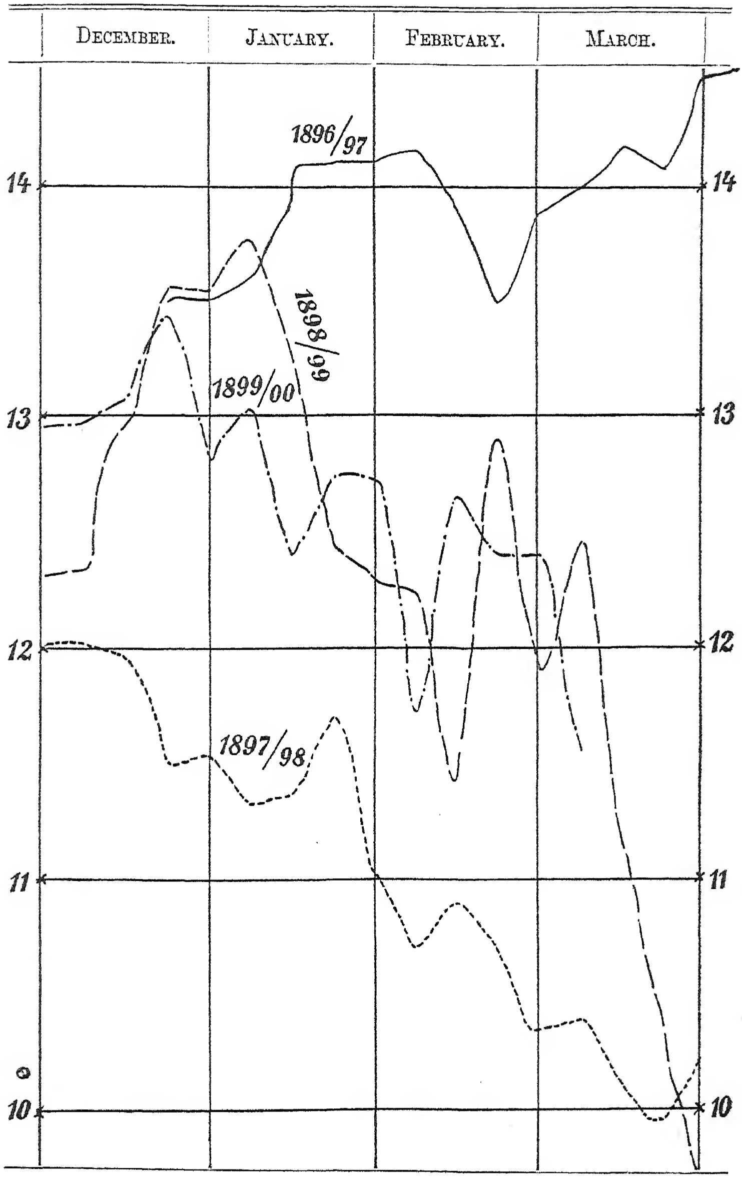
(Continued from page 69.)

II. The Sugar Content of the Cane.

The Egyptian sugar cane is by no means exceptionally rich in sugar. Moreover, till of late, little or nothing has been done in this country towards developing a cane rich in sugar, in spite of the nine large Daira Sanieh factories and the three modern French cane diffusion works. The cane is bought from the Arabs by weight without any consideration of its quality and richness in sugar, and paid for at a constant price. It naturally follows that neither the Arabs nor the large land tenants are disposed to supply the factories with a specially rich cane, since the latter hold out no inducement to them to do so. The Government factories, which possess large tracts of land, let these out on hire to the Arabs for cane cultivation. The diffusion factories possess no land; they are, however, endeavouring to obtain some on a lease of several years, and will then be able to supply a portion of the raw material they annually use, and thus in time will produce a better cane for their requirements. In order to show more clearly the contents and values of the Egyptian sugar canes the writer has arranged the campaign averages of several consecutive years in curves and tables.

In a good and frost-free year one can reckon on having an average campaign content of 14% saccharose on the weight of the cane (digestion method) under the present conditions of cultivation. At the beginning of the campaign it will be somewhat smaller; towards the end rather higher. In stormy years (when the cane is laid low), and frost puts in an appearance, one can only count on 12% saccharose in the cane. By means of the systematically drawn curves of saccharose content, the variations of the different years are shown in a striking manner. Specially opposite conditions prevailed in the consecutive years 1896-97 and 1897-98. Whereas in good years, *e.g.*, 1896-97, the sugar content rose steadily, and when mature was as high as 15% or even more, in frosty years on the other hand, such as 1897-98, not only was a cessation in sugar noticed, but even a rapid deterioration. By means of the curves one can also see that as long as similar climatic conditions prevailed at the commencement, the sugar content remained the same in different years. Thus till the end of the first week in January in the years 1896-97, 1898-99, and 1899-1900 the sugar content was about equal, whereas at the approach of frost the analyses fell off strikingly.

Curves of Sugar Contents according to the average cane analyses of the Campaigns 1896-97, 1897-98, 1898-99, 1899-00:—



Fourth weekly average—

December, 1896. December, 1898.
13·5% saccharose. .... 13·47% saccharose.

First weekly average—

January, 1897. January, 1898.
13·6% saccharose. .... 13·77% saccharose.

A noticeable uniformity is likewise shown in the analysis curves of the two frosty years, 1897-98 and 1898-99, inasmuch as in the latter year (when the frost was later and milder) the analyses are about 1% higher, and attain the calculated average of 11 to 12% saccharose.

In the following table the average analyses are given of the cane crops from an area of 8,000 feddans of land (say 4,000 hectars = 10,000 acres), of which 3,000 were devoted to cane:—

PERCENTAGE OF SACCHAROSE IN CANE.

DATE.	CAMPAIGN.			
	1896-97.	1897-98.	1898-99.	1899-1900.
December.				
1st week	....	12·2	12·34	12·98
2nd ,, ...	....	11·89	12·96	13·06
3rd ,, ...	....	11·51	13·53	13·48
4th ,, ...	13·5	11·55	13·47	12·8
January.				
1st week	13·6	11·33	13·77	13·03
2nd ,, ...	13·9	11·36	13·27	12·4
3rd ,, ...	14·1	11·70	12·42	12·73
4th ,, ...	14·1	11·04	12·3	12·72
February.				
1st week	14·16	10·7	12·25	11·7
2nd ,, ...	13·93	10·9	11·41	12·65
3rd ,, ...	13·5	10·7	12·91	12·4
4th ,, ...	13·88	10·38	11·9	12·4
March.				
1st week	14·01	10·44	12·46	11·55
2nd ,, ...	14·17	10·12	11·14	....
3rd ,, ...	14·09	9·97	9·74	...
4th ,, ...	14·42	10·21	....	....
April.				
1st week	14·43	....	....	....
2nd ,, ...	14·52	....	....	....
3rd ,, ...	14·75	...	....	....
Mean	13·99 %	11·02 %	12·26 %	12·4 %
Remarks	Frost free year.	Frost at beginning of December.	Frost at end of December.	Frost at end of December.

In February of all four years a similar small fall in the figures is noticeable, which is made up again later on. This arises from the fact that at the date in question the harvesting of the second year canes was commenced, the first cuttings of which were not fully ripened, whilst simultaneously the reaping of the first year canes, which were fully ripe, came to an end.

The first and second year canes are not of equal value as the following figures will show:—

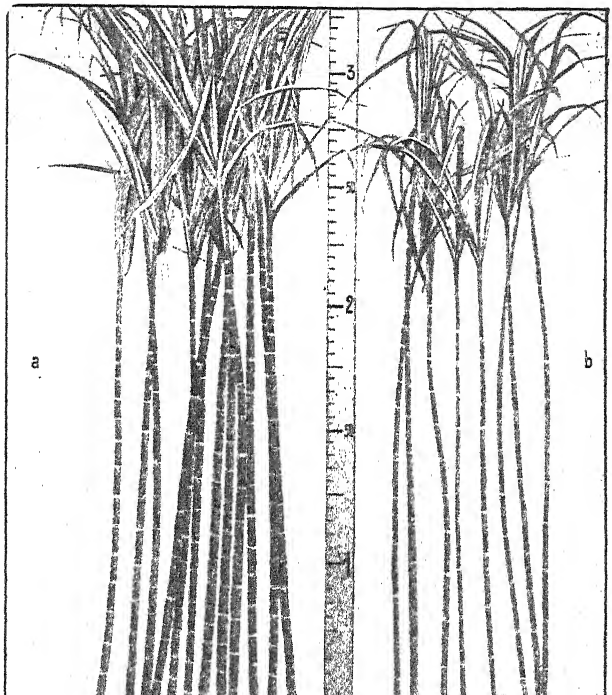
	First Year Cane. % Saccharose.		Second Year Cane. % Saccharose.
Campaign 1896-97..	13·9	....	14·0
,, 1897-98.... ...	10·5	....	12·0
,, 1898-99..	12·0	....	13·4

In the year 1896-97, owing to favourable climatic conditions and a late harvest, the sugar contents of the two kinds were about equal, with 13·9 and 14% respectively. In other years when bad weather was prevalent, the influence of the frost caused a difference of 1½% sugar in favour of the second year canes. This difference deserves some attention on the part of the planter as well as of the manufacturer. The chief point in the writer's opinion is to keep up the culture of second year cane cuttings. Some planters have of late confined their attention to the cultivation of first year canes (plant canes) because on their land the harvest from second year canes (ratoons) was not satisfactory enough to make up for the proportionally high rents they had to pay. It is obvious that one cannot get more from the land than it contains, all the more when careless conditions of cultivation without any manuring are the rule rather than the exception. Before long the harvest from first year canes will not supply a sufficient yield, on account of the Arabs' indifference to the fundamental rules of rational cultivation. The average plantings of the fellahs in Upper Egypt yield about 500 to 600 cantars per feddan in the first year (say 50 tons per hectar = 20 tons per acre), and about 150 to 250 cantars in the second (say 20 tons per hectar = 8 tons per acre). Specially good land, giving richer harvests than these, forms only a small percentage of the area under cane cultivation. With careful working up of the soil, rational methods of cultivation, and specially suitable manuring, the yield of the average ground will soon amount to from 750 to 850 cantars per feddan (75 tons per hectar = 30 tons per acre) in the first year, and 400 to 500 in the second (40 tons per hectar = 16 tons per acre). Such yields fully repay one for the care and labour given as well as for the outlay in manures, &c. In this connection the climate also comes into play. Were the Egyptian climate invariably as favourable as, for example, in 1896 up to the end of the harvest, then the results would probably be the same as occur now only with first

year cane. But, as experience shows, such favourable annual climates only occur at intervals of about five years. A large part of the first year cane will, as above stated, be heavily touched by frost, and the decrease in the yields is coupled with difficulties for the planter, as the factories are disinclined to saddle themselves with a loss for which they are not to blame, and make a certain reduction in price to planters for canes of poor value and sugar content. If second year cane be cultivated, that at least is saved, and draws the full price, so that a loss is only sustained on half the planting. Nevertheless, for an intelligent Arab second year cane cultivation remains in any case a profitable job, to say nothing of its advantage to the factory owner. Any attempt to replace second year cane cuttings by beet culture in Upper Egypt is invariably doomed to failure. Without going into details one can only say from experience gained in that direction that, judging by trials made in 1900, no Arab will grow beets any longer, that the experiments carried out on a large scale by the landowners and factories only resulted in disproportionately heavy expenses, that the quantitative yield in the plain was on the average but half that to which one may look forward to in Europe, and that the competition of beet cultivation cannot hold out in the long run against moderately well cultivated second year canes.

The recorded analyses of the experiment fields and the available tables of averages give satisfactory results as to the general saccharose content of the Egyptian canes. The degree of maturity is estimated by the age, and the saccharose and glucose contents. The Arab records his diagnosis of these conditions simply by tasting the cane, whereas the cane planter or manufacturer must keep himself acquainted by continuous testing with the state of the cane fields. The figures of sugar content in canes given in this treatise all relate to direct analyses by means of the *digestion method.* Many of the factories only undertake analyses of juice, and, by means of a so-called quotient, calculate therefrom the sugar in cane; as it is somewhat difficult to divide a large quantity of sugar cane so as to obtain a good medium sample, the factor or so-called quotient by which the sugar content of the juice is multiplied in order to ascertain the proportion of sugar in the cane, varies according to the pressing operation. The fibre of a ripe cane amounts to about 10%, and therefore a factor of 90% should be the correct one. But in pressing in a mill one always obtains a sweeter syrup than the supposititious one of 90%, due to the fact that the fibre retains a portion of the juice which is poorest in sugar. The less pressure on the rolling mill, the richer in sugar the juice will be. Hence the factor varies according to the pressure; for a juice extraction of 60% of the cane, it is (say) 84, for 65% 85, and so on. From many analyses carried out on parallel lines by the writer he found at the end of a year that for a juice extraction of 65% his laboratory press gave a factor of 86·3.

EXPERIMENTAL FIELD, 1898 (PLANT CANES).



	a	b
Manure per hectare..	300 kgr. nitrate of soda. 500 ,, Thomas slag. 750 ,, molasses ash. (corresponding to 200 kgr. sulphate of potash.)	Not manured.
Weight of canes per hectare ..	83 metric tons.	57 metric tons.
,, ,, ,, acre	37 ,, ,,	(23 tons per acre.)
Per cent. of saccharose in cane	12·5	

The distribution of the sugar in the cane is dependent on the anatomical construction of the plant. The proportion decreases from the bottom upwards, though in such a way that the highest percentage is just below the middle portion of the stem. The internodes contain more sugar (up to 3% more) than do the hard nodes, nevertheless the sugar is more concentrated in the latter. It is bad practice to fix on a single stem piece for an average analysis of the cane. This is neither a scientific nor a practical way for testing the cane and ascertaining its value; one should rather take a large number of cane pieces divided lengthways, from which are collected half pieces divided alternately above and below, so as to make the sample as much as possible an average one. The white unripe tops of the cane stem always form a bone of contention between the factory and the planter at harvest and delivery time. After a number of experiments the writer found that the entirely white top joints contained on the average 5·35 % saccharose in cane and 41·3 purity, and the topmost reddish joints 7·2% saccharose and 54·2 purity. More than 50% of the unripe top-joints break off at the harvest on stripping off the leaves. These cane tops may be ground off if the quality of the juice of the other canes is an average one. If, however, they are planted out, then both parties are gainers, the factory obtains proportionally more sugar and the planter better planting material.

But of greater importance is it for the factory and field administration to make definite delivery arrangements for the amount of cane to be cut. The sugar cane, when once cut, is very undurable raw material, and requires immediate treatment if all the sugar is to be obtained without loss; for each day the cane lies about on the field a loss is involved by either party. This daily loss in weight was ascertained to amount to from 1 to 2% of sugar. A diminution in the sugar content is not always clearly visible because the cane loses weight at the same time through evaporation. One can sometimes under favourable circumstances find more sugar when the cane has lain some days, yet if one takes into consideration the decrease in weight, and the simultaneous increase in glucose and non-sugar, as well as the fall in the quotient of purity, the manufacturer will realize that the small percentage decrease in weight thus resulting is really to his disadvantage. It is therefore in the interests of both sides, the planters as well as the manufacturers, to work up the canes as soon after cutting as possible.

III. Tillage of the Soil.

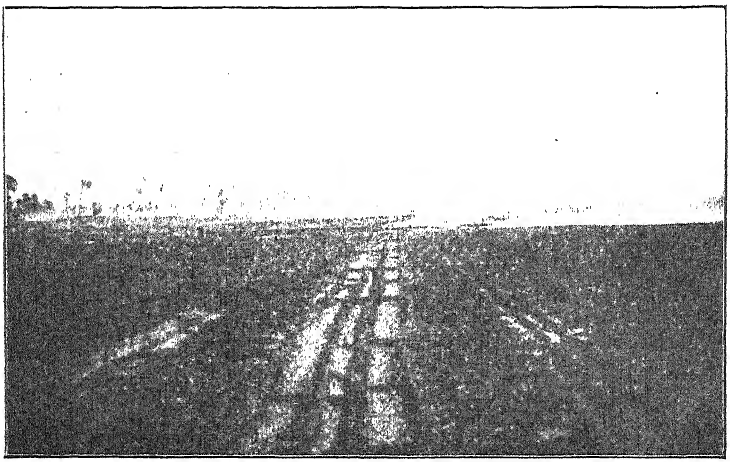
The fertile portion of the Egyptian soil is confined to a strip of land a few miles broad on either side of the Nile and its canals. In Upper Egypt, from Cairo southwards, where any cultivation but that of cane is out of question, this land has been taken from the desert by means of Nile deposits, and in the delta from the sea. The period of time during which these alluvial deposits have been settling extends back several thousand years. In the neighbourhood of Memphis, for example, investigations carried out by Horner established the fact, that during 3,000 years a layer of only 2·85m. had been formed. This is equivalent to ·0009m. in one year, or a layer of 90mm. per century. The present depth of the Nile alluvium is about 10m., beneath which lies the desert sand. The subsoil of the fields is formed of ancient deposits which in the whole cultivated Nile valley have not yet seen the light of day, being overlaid with several thousand years' silt, as well as the more recent layers of deposit due to the Nile's overflow. Only in the south east by the Red Sea do we come across coal formation. The rock stratum in Egypt proper near the Nile consists of chalk, marl, sandstone, and clay, in conjunction with old tertiary deposits. The purest limestone forms the precipitous shores of the Nile main stream.

The narrow strip of fertile land in Upper Egypt only extends inland a few miles on both sides of the Nile bank, and has a depth of from five to twenty metres. This alluvial soil consists of Nile mud accumulated since the earliest ages and mixed with sand blown from the desert. There are already on record different analyses of these earths. The following ones carried out by the college of agriculture at Guizeh, near Cairo, form good examples of the Upper Egyptian soil.

Soil Analyses.

	At Cheik Fadl.	At Cheik Fadl.	At Charkieh.	At Charkieh.	Yellow Earth at Beni-Mazar	Black Earth at Beni-Mazar
	%	%	%	%	%	%
Insoluble matter.	59·05	52·83	61·01	57·01	69·38	57·97
K_2O	0·88	1·33	0·72	0·87	0·7	1·88
Na_2O	0·89	0·95	1·31	1·16	0·56	2·16
CaO	5·31	5·84	3·34	2·27	4·36	3·39
MgO	2·79	3·14	1·99	2·95	1·76	2·57
MnO	0·33	0·36	0·09	0·06	0·09	0·21
F_2O_3	9·34	10·26	9·84	11·69	6·72	9·78
Al_2O_3	14·55	16·19	12·66	14·47	8·91	11·68
Cl	0·05	0·09	0·89	0·12	0·64	1·6
SO_3	0·12	0·3	0·22	0·19	0·26	0·36
P_2O_5	0·23	0·38	0·25	0·366	0·21	0·29
CO_2	1·56	2·37	1·05	0·48	2·18	1·05
N	0·044	0·043	0·479	0·205	0·66	0·43
Loss in calcinating.	4·82	5·49	6·62	8·38	4·21	6·9

A fresh quantity of plant food is supplied to the ground from the Nile mud whenever watering takes place. The rock formation of the Abyssinian highlands has been shown to be so exhausted by continuous washing out by rain, that the process of fructification in the Nile valley by means of watering is not now the same as in the olden times. In by far the greater portion of the delta and Upper Egypt the early Nile culture has been replaced by intensive culture. The previous cereal culture has already exhausted the soil, hence within the last century or two, the expansion in the cultivation of cotton and cane has led to the establishment of an intensive method of agriculture. The exhaustion of the soil and a deterioration in yields have been the results, as every large landowner knows. Single cultures are consequently seldom or never undertaken now without



Ready Planted and Irrigated Cane Field.

manuring; these include maize, durrah, and 2nd year canes. Other cultures in crop rotation feed to a large extent on the after-effects of the previously applied manures. This certain exhaustion of the soil requires, in most places, an application of manure, if profit in the husbandry is desired, and it is often well to resort to artificial manures, since the hitherto employed natural ones are often anything but adequate.

Amongst the available manures made use of so far, we find the following:—In the first place, the Nile water with its soluble and suspended constituents, is used; it fructifies the land either artificially or naturally, by overflowing during the fallow period, or by means of irrigation. Under the assumption that the Nile water during the

inundation of the soil at high water deposits 1 kg. of mud (called limon) for each cubic metre, we find that a hectare annually receives 14 tons of limon, which latter includes about 15 kg. nitrogen, 45 kg. lime and magnesia, and about 38 kg. potash and soda. These quantities do not suffice for intensive cultivation, as is apparent. Moreover, the benefits of flooding the fallow land for several months only extend to the subsequent winter cultivation (called shitwi), which lasts from October to May.

The composition of the Nile water varies, according to the time of the year, with the rise and fall of the water. The writer found at low Nile:—

Matter in Suspension	0·21
Matter in Solution	0·26

and at high Nile:—

Matter in Suspension	1·22
Matter in Solution	0·15

In the months of June and July the proportion is the highest in the so-called green water, and thereafter in August, September, and October, when the Nile water has assumed the characteristic reddish-brown colour, it contains proportionally little nitrogen.

	Nitrogen. Per cent.
In June and July	0·65
In August, September, and October	0·019

The writer has not so far carried out any analyses of the Nile water for ascertaining the proportion of soda and phosphoric acid, but in the work of Dr. Mackenzie in Journal III., 1899, of the Khedivial Agricultural Society, this question is fully treated.

The conclusion drawn from all the experimental investigations of Nile water is, that it cannot be used as a substitute for manure with the intensive system of cultivation which is now found all over Egypt.

From its source the Nile traverses almost every geological formation so that a good deal of every kind of mineral and organic plant food is absorbed in its passage. The reason why the present water does not possess the extreme fruitfulness it had in former days may be set down, firstly, to the present more ambitious system of Egyptian husbandry, and secondly, to the fact that the soluble and easily decomposed rocks have been mostly from lapse of time more or less washed away, and now only the more durable layers remain, which are but slowly dissolved and consequently not so plentiful.

(To be continued.)

THE EXPRESS VACUUM PAN.

By Geo. Stade, Berlin.

In working off the concentrated liquor as it leaves the evaporator the following points have to be taken into consideration.

Before the liquor enters the vacuum pan the suspended matter which the concentration generates *i.e.* the sulphate of lime, the carbonates, the silicates, &c., have to be eliminated by an effective mechanical filtration as otherwise the sugar assumes a dull appearance, and the crystallization cannot be so effective as the suspended matter surrounds (suspended in the mother-liquor) the growing grains and hampers their close contact with the mother-liquor. This close contact is of vital importance for quick and exhaustive crystallisation. Furthermore, the suspended matter forms the disagreeable incrustations on the heating surface and on the shell, seriously effecting a quick boiling. No refiner would dare to work with cloudy liquor if he had to make products of any special quality and even though raw sugar is not to be compared with refined, still the rule "that good sugar can only be made out of clean filtered concentrated juice," however pure or impure the liquor may be otherwise, holds good in this case also.

The higher the concentration of the liquor, the more dangerous the chance of chemical deterioration of the saccharose. If the liquor is too alkaline the masse-cuites begin to assume a brownish colour and the higher the temperature is raised, the more deterioration takes place; the glucose is transformed into uncrystallisable matter which impairs crystallization and yield by simultaneously increasing the viscosity. If, on the other hand, the liquor is acid the formation of glucose takes place and the higher the temperature and the longer the boiling lasts, the more glucose is generated, and loss in sugar and often false grain is the result. Consequently, the concentrated liquor ought to be made as neutral as possible to avoid the above mentioned losses and inconveniences.

The evaporation and boiling-down of the liquor has to take place in the shortest possible time with lowest temperatures and with utmost circulation to avoid the burning of the delicate saccharine matter and consequently highest possible vacuum is necessary. If this is done, even and regular grain and a high yield will be the result with the most exhausted molasses.

The pans have to be arranged in such a manner that the incoming liquor can be started boiled down in small quantities, consequently the heating surface has to be placed as low as possible. On the other hand the heating system must allow a

quick and perfect emptying of the pan, letting the highest concentrated masse-cuites escape without hinderance so that little or no steaming out is required.

The heating system has to fulfil all the requirements asked for in a good evaporator and the efficiency of an evaporating system heated by steam is dependant on the following vital points:—

(*a.*) On the circulation of the evaporating liquor around the heating surface. The more effective this circulation takes place in a certain time, the more rapid is the transfer of the units of heat from the heating medium (the steam) to the evaporating liquor—as the observations of Joule, Ser, and others prove that the additional transfer of heat between the steam and the liquor, on account of the circulation of the latter, is equal to the cube-root of the acceleration of the liquor.

(*b.*) On the circulation of the heating medium around the heating surface. It is a well-known fact that the more the steam comes in rapid contact with the heating surface the more efficient the latter is—even if no complete condensation takes place.

(*c.*) On the rapid removal of the condensed water. The water, of course, acts as a considerable hindrance in forming a bad heat-conducting coat on the heating surface separating the steam from heating surfaces. The more quickly and the more completely the condensed water is drawn off, the more effective will the heating surface be. Consequently, the removal of the water will take place more quickly in short inclined tubes, for instance, than in long vertical or horizonal pipes.

(*d.*) On the removal of the air in the heating system. Air is a very bad heat-conducting medium, it is specifically heavier than steam and consequently collects in the lower part of the heating system from which it has to be drawn off either by a separate pipe or blown out with the condensed water.

(*e.*) On the removal of the gas. This is particularly the case in a system heated by vapours containing non-condensing gases as, for instance, steam generated from sugar juice. The gas collects on the upper part of the heating system and must be drawn off accordingly as it otherwise renders a part of the heating surface useless.

(*f.*) On the clean surface of the heating system in and outside the steam chamber. Outside:—incrustations have to be avoided. Inside:—the coating formed by the oil usually contained in exhaust steam, is also a non-conductor of heat, the action of which is of no little importance.

(*g.*) On the material of which the heating surface is formed. Copper and brass conduct the heat about 25% better than iron or steel.

(*h.*) On the rapid removal of the generated vapour and the unthrottled entrance of the heating steam. Consequently, an ample section of all pipes, thorough effective condensation and vacuum-

pumps working with a minimum of dead space between piston and covers are required to keep up the efficiency of an otherwise perhaps well-constructed evaporator.

Furthermore, as to the advisability of the acceptance of a modern vacuum pan, the following points have to be taken into serious consideration.

(*a.*) The evaporator should work without any loss by entrainment, consequently, safety devices must be provided to prevent losses—which are then impossible even if the system is carelessly handled.

(*b.*) The heating system should be arranged in such manner that a thorough cleaning is possible and that defective tubes can be changed without taking the whole system apart.

(*c.*) Last not least—the maximum of liquor should be evaporated per unit of heating surface at a minimum expense as to cost of plant and quantity of steam.

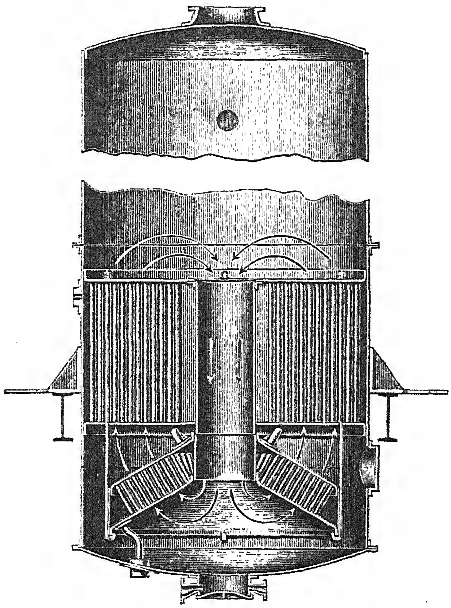
(*d.*) The liquor entering the pan while boiling has to be distributed in the most perfect and speedy manner so that the grain comes into contact with fresh liquor all through the pan and that no liquor sections or nests are formed as can be seen often with ordinary draw-in arrangements consisting of open pipes, even unperforated. The quicker the drawn-in liquor circulates round the grain or, *vice versa*, the sooner the state of supersaturation is reached for further taking in liquor.

None of the old systems of pans comply with all the above mentioned points. As long as the boiling down was not carried on very far and the complete exhaustion of the mother-liquor was considered with indifference as a secondary matter, the old pans with coils did their work more or less to the satisfaction of the manufacturer. But in these modern days the proper working-off and the complete exhaustion of the molasses is a desideratum aimed at by all experts and the keener the competition on the market, the more attention has to be bestowed on the rational work of the masse-cuites, be it to make sugar of direct consumption with following by-products, or be it to make, according to Dr. Winter's Java Process, only first sugar of high polarisation and exhausted waste molasses in one operation without any by-products within 36 hours.

That the old coil vacuum pans with their worms sitting mostly one on top of the other did not satisfy the critic with regard to any of the above mentioned points is clear enough. New pans then turned up with the most complicated ways of arranging the heating system and had to be abandoned again. They did not last or they could not be cleaned or they could not be repaired. Other simpler pans with short well arranged bends proved a better success with regard to practical working, but here the lack of proper circulation common to all pans with coils—had to be backed up by additional implements such as blow-in arrangements for air, gas, &c., if a proper full

circulation of the masse-cuites was required at the finishing of the strike.

Better results from a modern point of view were given by the calandria pan with short wide tubes combined either with a special heating system below the calandria for high pressure steam for mechanical circulating purposes or better still with mechanical stirring gear for forced artificial circulation. The sketch below shows such a combination which gives splendid results for evaporation (with long tubes) or for granulating purposes with short wide tubes in the calandria.

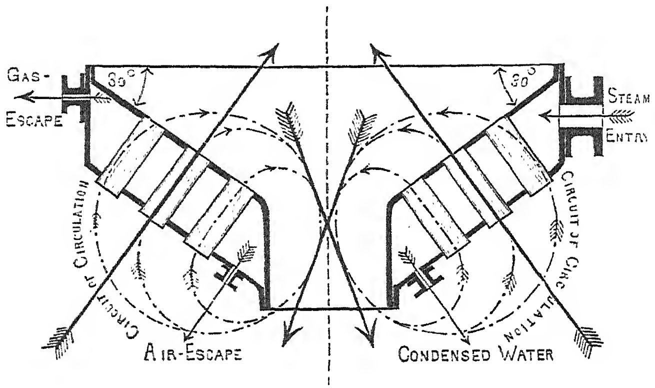


Though in these systems it answers very well to increase—and even sometimes double—the capacity of evaporators, they have the drawbacks of being very expensive, particularly those pans with stirring gears, and are not exactly suitable for all purposes.

Taking now carefully into consideration the above mentioned fundamental principles the Express Vacuum Pan has been designed and was put to work last crop—giving results which have surpassed anything expected. This most modern pan consists of one or more heating systems which are arranged in the following manner. The cast iron, wrought iron or yellow metal calandria consists of conical parallel plates which are fixed like a double funnel and

contain a large central circulation pipe inside and a cylindrical ring outside. The heating tubes are fixed at such an angle that their central lines form a kind of parallel or central radiatiform.

THE EXPRESS VACUUM PAN
(Scheme of Circulation).



BERLIN: C.2. GEO. STADE, C.E.

The steam enters at the upper part of the calandria, the condensed water escapes at the lowest point while for air and gas separate pipes are arranged to insure highest efficiency of the system. The tubes are short and wide. They deliver even the most concentrated masses up to 5% water to the top. The tubes being set inclined the masses have to go out sideways and are forced to circulate sideways in or outside of the system (this, of course, depends on the arrangement of which several varieties can be installed). The figure below shows a pan as arranged for the new Process "First Sugar only and exhausted Waste Molasses in one operation," for heavy thick masses. It will be easily understood that the lower system effects a vigorous circulation in the lower part of the pan where also the patent draw-in arrangement is fixed, blowing-in and distributing the liquor.

There are only about three or four supports required for one system, consequently there are no complicated stays to hinder the full circulation which is bound to take place in a methodical forced system. On the other side the inclined position of the whole system facilitates the emptying of the pan considerably so that with most concentrated masse-cuites of 5% water the strike gets out completely in 25 minutes without the help of any steam and without any massecuite remaining in the pan. The circulation remains in action to the last moment of the boiling strike, and all the tubes get clear of

masse-cuite without delay. The movement in the pan is very even but strong so that all the grains are kept equally in contact with fresh mother-liquor causing a perfect completion of the crystallisation process.

One of the chief points of the Express Vacuum for practical engineers is the easy access to all parts of the system. The tubes can be reached from outside and inside so that in case of any leakage repairs can be effected in the most simple manner.

Going over the points put down as fundamental in introducing this pan, the following advantages may be summed up :—

1. As the circulation is the highest possible the boiling down requires very little time, temperature remains low, no lumps are formed as with coils, regular nice grain results, consequently high yield in sugar and exhausted runnings are obtained.

2. The system can be arranged as low as possible, boiling can take place a few minutes after drawing-in as all the tubes are at once covered with liquor.

3. The emptying of the pan takes place in 25 minutes, no masse-cuite at all remains in the pan—as there are no horizontal surfaces where deposits can collect—no eventual steaming out is required.

4. The circulation of the steam in the calandria is a most effective one as no long spaces have to be traversed. The steam comes in rapid contact with the heating surface.

5. The condensed water runs off the heating surface at once and goes to the deepest point of the system, consequently the tubes are always free of water and rapid boiling and high efficiency, even with low pressure steam results.

6. The air is blown out on the lower part of the system—no dead space.

7. The gas escapes at the upper part of the system — no dead space.

8. The rapid circulation causes the incrustations to be done away with in the tubes and in the calandria, as no oil can collect, but must drop off.

9. The brass heating tubes transfer the heat in the most rapid way.

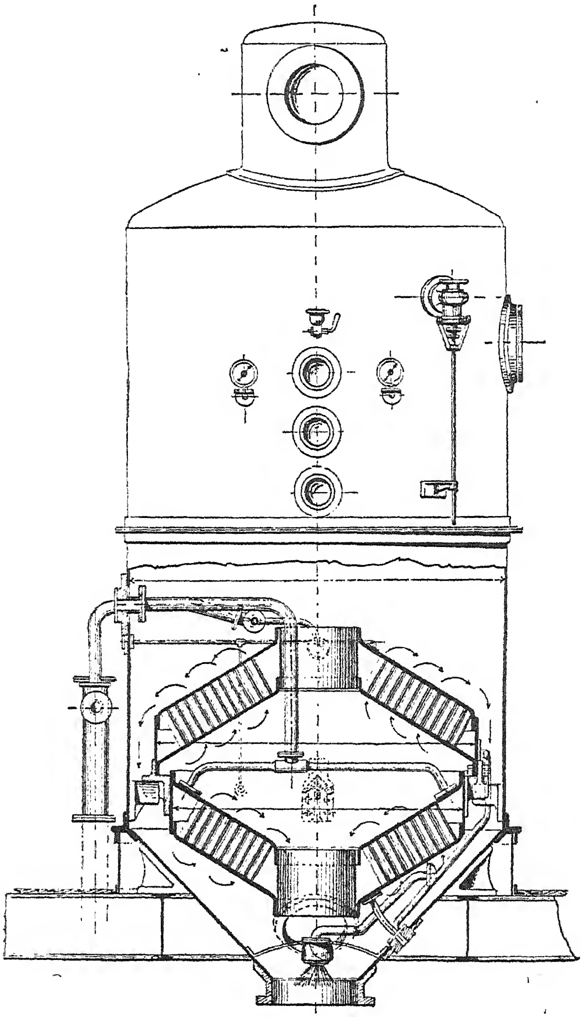
10. All pipes have ample sections for vapours and liquids to escape.

11. As the boiling in spite of the rapid circulation is a forced one, the surface is smooth and no entrainment possible, the draw-in at once divides the liquor in the whole strike from below.

12. The heating system can be cleaned thoroughly, and defective tubes can be changed without taking the whole system or the pan to pieces, easy access to all parts of the system.

13. The maximum of liquor can be evaporated with a minimum of steam, as the co-efficient of transmission has been proved to be 22 on the average of a whole strike with 5% water.

THE PATENT CIRCULATION EXPRESS VACUUM PAN.



Arranged for

Quality Sugar,

Demerara-Crystals, Granulated, and for Refineries.

The Algermissen Sugar Factory had one of their pans transformed last season into an Express Vacuum. In reporting results they stated: The Express Vacuum was heated with vapour of 0·9 atmospheres—equal to about 13·3 lbs. steam per square inch. The total heating surface is 41 square meters (or 450 square feet). The time of boiling down and finishing a strike of 19 tons of masse-cuite (say of 13 tons sugar) averaged about three hours. The average contents of water in the masse-cuites was 5%. The circulation of the masse-cuite was from beginning to end always exceedingly brisk, so that a beautiful, even, sharp grain resulted and false grain never made its appearance. The total of our first product was sold to a refinery making granulated without remelting. The discharge of a complete strike of masse-cuites at the high density of 5% water took place in 25 minutes without the slightest difficulty, and never did any masse-cuite remain on the heating system, neither on the shell nor in the tubes. The quotient of purity of our running from first sugar was extremely low.

At the Teterow Sugar Works the Express Vacuum constructed for their last crop gave very satisfactory results. They boil down now with 38 square meters heating surface and use only exhaust steam of 0·25 atmospheres—4 lbs. per square inch—the same strike which they boiled in former days with direct steam and copper coils.

To increase the efficiency of their evaporating system, the Arnswalde Sugar Works decided to accept the Express Vacuum System for the first body of their Quadruple Effet. The system consists of a total heating surface of 40 square meters (440 square feet), and can be worked with exhaust and direct steam. The following figures obtained by the combination of their old vertical tube calandria with the Express Vacuum Pan system, are the result of careful repeated experiments in weighing the condensed water:—The 40 square meters (440 square feet) of the new system, compare with the following surfaces calculated in old system surface.

1. Heating with steam of 1 atmosphere = 15 lbs.

   These 40 square meters (440 square feet), were equal to 101·6 square meter (1,118 square feet), surface of the old system consequently:—

   100 surface of Express Vacuum System does the same work as 254 surface old calandria.

2. Heating with steam of 2 atmosphere = 30 lbs.

   These 40 square meters (1,440 square feet), were equal to 240·4 square meters (2,644 square feet), surface of the old system consequently:—

   100 surface of Express Vacuum System does the same work as 661 surface old calandria.

The exact figures given were as follows:—

(a) Heating surface of old calandria = 350 square meters (3,850 sq. ft.)
Steam pressure used in old calandria = 0·5 atm. (7·5 lbs).
Evaporation per sq. meter and hour = 15·54 kilo water,
or say per square foot and hour .. = 3·12 lbs. water.

(b) Surface of the Express Vacuum Pan System .. .. .. = 40 square meters (440 sq. feet).
Steam pressure used in new system 1 atmosphere .. .. .. = 15 lbs.
Evaporation per sq. meter and hour = 39·59 kilo water,
or say per square foot and hour .. = 7·94 lbs. water.

(c) Surface of the Express Vacuum Pan System .. .. = 40 square meters (440 sq. ft.)
Steam pressure used in new system = 2 atm. (30 lbs.)
Evaporation per sq. meter and hour = 93·49 kilo water,
or say per square foot and hour .. = 18·76 lbs. water.

Consequently there is no doubt that the new system is a great improvement over the old one.

PROCESS FOR REGULATING SUPERSATURATION IN THE CRYSTALLISATION OF IMPURE SUGAR SOLUTIONS.

(Patent No. 134915 of Dr. Hermann Claassen.)

This process was devised with a view to undertaking the regulation of supersaturation of mother syrups in the crystallisation in motion of afterproduct masse-cuites boiled to grain, by means of adding water in a systematic manner, so as to ensure a more successful crystallising of the mass, and thus render a good centrifugalling possible.

Under Part 4 of the German Patent No. 117531, the addition of water to a masse-cuite crystallised in motion, which has been produced according to the process of this patent is the subject of a protection. This addition of water serves in this case (as set forth in the description) only to decrease the crystallisation-retarding viscosity and should only take place when this viscosity becomes clearly apparent, which generally occurs when the temperature falls below 75 C. By this patent the addition of water must not take place at higher temperatures, and in the case of low ones may only be carried out when the viscosity becomes noticeable.

The new process comes into play at an essentially earlier moment than that at which the viscosity becomes apparent, since it has for its basis the supersaturation of the mother-syrup. Consequently it is applicable for every kind of masse-cuite boiled to grain. The regulation of the supersaturation of mother-syrups in such masse-cuites is so arranged, that the formation of small grain is prevented to a practical extent, and any alteration in the composition of non-sugar substances (which are formed under high temperature when the water content of the mother-syrups is low) is hindered.

By highly supersaturating the mother-syrups during crystallising out, not only is this crystallisation disturbed, but it finally yields a masse-cuite that spins badly, and then gives a sugar of little value. For the newly formed small grain never increases sufficiently in size as to be fully retained in the centrifugals. Not only are the returns hereby reduced, since the small grain is partly thrown off with the molasses, but it likewise renders the spinning more difficult, owing to its forming with the slimy syrup a layer on the sugar in the centrifugal basket, and finally it raises the quotient of purity of the molasses owing to the fine grain being largely thrown off with them. Again owing to the mother-syrup not being able to fully separate from these crystals, the resulting sugar possesses a low quotient of purity.

In working out this process, it was found that the maximum limits permissible for the quotient of supersaturation of the mother-syrups in the crystallisation in motion of after product masse-cuites boiled to grain remained under 1·25. By the Patent No. 117531, the lowest limits in the boiling of the syrup are fixed at 1·25. A masse-cuite boiled by this method, will on leaving the vacuum pan have reached or even surpassed the highest grade of supersaturation permisssible under the present process. The supersaturation will be further increased by the cooling owing to the crystallisation not proceding quickly enough to enable the former to appreciably reduce it; also by the lessening solubility of the sugar resulting therefrom.

By the present process, the supersaturation is so regulated that this quotient of 1·25 is never exceeded, and the addition of water commences before the quotient is reached. Likewise by this process the supersaturation where further crystallising out takes place is so regulated that the degree of supersaturation is arranged to correspond with the purity of the mother-syrups, which latter purity will still fall, owing to the loss in sugar by the crystals formed in the crystallising out process, and moreover the water content corresponding to the decreased purity of the mother-syrups increases, and the quotient of supersaturation is lowered.

For the quotient of supersaturation, that figure should be taken which results from the division of a by b, where a is the amount of sugar from a mother-syrup dissolved in one part of water, and b that amount from a saturated syrup which at the same temperature is contained in one part of water. These figures have been calculated by the inventor and are shown in the table further on.

Besides these tables, the following determinations serve to aid in the calculation of the quotient of supersaturation, and of the control of the crystallisation process:—

1. The water content of the mother-syrup.
2. The sugar content of the mother-syrup.
3. The purity of the mother-syrup.
4. The temperature.

If in the course of our experiments we find a higher sugar content than ought to exist with the three factors for a saturated syrup, it shows that the mother-syrup is supersaturated. If, for example, the sugar content in a concentrated solution of syrup should be 1 part water to 5 parts sugar (according to the table of saturation for impure syrups), and in the sample tested shows 6 parts of sugar to 1 of water, then we divide the figures, viz., $\frac{6}{5} = 1\cdot20$, and this resulting quotient stands for the quotient of supersaturation in the particular example. It is clear that by the addition of water to such a mother-syrup, the supersaturation quotient can now be reduced and brought to the required degree.

In calculating the amount of water to be used, one must take into consideration the total quantity of mother-syrup in the masse-cuite. This mixing increases the water content when crystallisation by cooling takes place on account of the sugar separated from the mother-syrup. The proper mixture can be calculated by the usual formula of proportion.

To ensure the retention of equal quotients of supersaturation, the amount of water to be added must be reduced in accordance with the fall in temperature, provided the quotient of saturation is not altered by this change in temperature.

The conditions of saturation of impure syrups alter in an entirely different manner to those of pure ones. In this case not only the temperature but also the constitution of the syrup, and especially the amount of non-sugar present have a great influence on the conditions of saturation. With impure mother-syrups of under 75 purity, the solubility of the sugars is much greater than with pure sugar solutions, and it increases with the amount of non-sugar. And the influence of an equal quantity of non-sugar on the solubility of the sugar is so much the greater the higher the temperature. For example, in a saturated syrup of about 60 purity at 80° C. 5·8 parts of sugar are dissolved in one part of water which is 1·6 times as much as in a pure saturated sugar solution at the same temperature, while the same syrup is saturated at 50° when it contains 3·4 parts of sugar to 1 of water, or only 1·3 times as much sugar as with a pure saturated solution at 50°.

The following table demonstrates the quotients of saturation for syrups of about 60 purity:—

Temperature (centigrade).	Parts of sugar dissolved in one part of water. In the saturated syrup.	In a pure saturated solution.	Quotient of saturation of the syrup.
80	5·8	3·6	1·6
70	4·8	3·2	1·5
60	4·1	2·9	1·4
50	3·4	2·6	1·3
35	2·8	2·3	1·2
20	2·3	2·0	1·15

Since, as shown, the solubility of the syrup depends on its purity, the condition of water will differ according to the purity, because the solubility of the syrup is so much the smaller the purer it is, and thereby the quotient of saturation will be altered.

The latter is lower with pure than with impure syrups. With syrups of about 75 purity the quotient of saturation = 1, *i.e.*, the proportions of solubility is about the same as with pure sugar solutions. The proportions of solubility approach below 75 purity (approximately proportional to the falling purity), the proportions of solubility of the foregoing tables for molasses syrups.

For estimating the amount of water to be added, the following determinations come under consideration.

1. That the water content of the mother-syrup increases percentially subsequent to the crystallising out of the sugar, and is greater at the beginning than later on, because the purer the mother syrups the quicker they crystallize.

2. That with a fall in temperature the solubility of the sugar decreases.

3. That this decrease takes place to a greater degree in the case of impure syrups than with more or less pure ones, which degree is expressed by the quotient of saturation.

4. That with falls of temperature as nearly as possible similar, an entirely definable rule can be made for the amount of water to be added to each syrup if the purity and water content of the mother syrup in the masse-cuite are known.

When crystallising according to the present process one regulates the water content of the mother-syrup so that taking into consideration the purity of syrup and the falling temperature, the quotient of supersaturation remains between 1·25 and 1·02. In practice one can reduce this when progressive crystallising out and cooling follows.

These rules laid down for keeping up the supersaturation point show that when boiling down after-product masse-cuites, boiled to grain according to one's choice, the quotient of supersaturation of the mother-syrup is in general already too high for crystallisation in motion. One must in that case add such a quantity of water to the masse-cuite either in the vacuum pan or when filling out in the crystallisers, as will bring down the quotient to 1·25, in accordance with the terms of Patent No. 117531, which, as above mentioned, stipulates that the addition of water must not be made at that moment. But having regard to the falling temperature, one can proceed further with the addition of water.

As a matter of course one need not specially estimate the quotient of supersaturation for each step in cooling; it is only necessary to calculate it for certain temperatures, and estimate therefrom the intervening points. Since the crystallising out takes place in a

constant manner under the application of the present process, one can also find out accurately the water addition for particular periods in the falling temperature without making special calculations for each period. But if the addition of water is commenced too late, *i.e.*, after the viscosity has become apparent, then the influence of the strong overconcentration will already have begun its work, and cannot now be remedied by increased addition of water, as the dissolving of the small grain is only possible by having strong undersaturation of the mother-syrup which would however attack all the available crystals as well. The aforementioned mistakes could not however thereby be remedied.

We will give an example of calculating the amount of water required for attaining the quotient of supersaturation to ensure a proper crystallisation.

A masse-cuite is of 75 purity at 90 C. of which the mother-syrup has a purity of 68 and a water content of $8\frac{1}{2}\%$. The amount of syrup comes to about 800 litres per cubic metre of masse-cuite.

At this temperature and purity the quotient of supersaturation is about 1·3, and about 5·4 parts of sugar to 1 of water from the saturated solution.

We find however by experiment 7·32 parts of sugar to 1 of water. The quotient is then $\frac{7\cdot32}{5\cdot4}=1\cdot35$, which is too high. We must therefore add water so as to reduce the figure to 1·25. The quotient of 1·25 involves a proportion of 6·7 parts sugar to 1 of water. We must therefore have instead of 1 part water $7\cdot32 \div 6\cdot7$ or 1·1 part of water, in other words we must add at least 1 part more water. As we have 100 kg. of water in 800 litres syrup, we must add at least $100 \times 0\cdot1 = 10$ kg. water to each cubic metre of masse-cuite.

By means of another example the working of this process is shown where the amount of water a particular fall of temperature is allowed to remain the same, and where the degree of supersaturation, corresponding to the falling temperature and the decreasing purity of the mother-syrup, falls continuously.

A masse-cuite of 75 purity is boiled down at 90° C. to a 6·8% water content. The mother-syrup is found to have a purity of 68 and a water content of $8\frac{1}{2}\%$. The supersaturation quotient of the same is therefore 1·35. It is however desired to begin the crystallisation with a supersaturation quotient of (say) 1·15. The mother-syrup would then contain 10% of water, and it would be necessary to add 17·5 litres of water to 1 cubic metre of masse-cuite preferably in vacuo.

After the filling out in the crystalliser, the masse-cuite already treated with water will have a temperature of about 88 C. With the addition of water the masse-cuite is now further cooled.

The temperature is allowed to fall somewhat as follows:—

After 24 hours to about	.. . .	80°
,, 48 ,, ,,	....	70°
,, 72 ,, ,,	.. ..	58°
,, 96 ,, ,,	....	45°

The crystallizing out is then probably complete.

By means of the previous process the amount of water to be added has been calculated. The addition of water to one cubic metre of masse-cuite was estimated as follows:—

Temperature. ° C.	Addition of Water, in Litres.	Temperature. ° C.	Addition of Water, in Litres.
84°	3·5	64°	3·5
80°	3·5	60°	3·5
76°	3·5	55°	3·5
72°	3·5	50°	3·5
68°	3·5	45°	3·5

The mother-syrup will then possess a quotient of supersaturation of 1·06. At the end of the fourth day the mass is desugarised till the molasses are pure, and the latter, practically free from small crystals, and then well centrifugalled.

The amount of water to be added varies, as above mentioned, with the purity of the masse-cuite, and the water content of the mother-syrup.

In consideration of the proportions given in the previous examples, proportions are given in the subjoined table which demonstrate the alteration in the amount of water to be added.

Water content of the mother syrup when filling out. per cent.	Water addition in litres per cub. metre of masse-cuite and per 4°C. of cooling with a mass-cuite purity of 70	75	80
8	7·5	6·0	4·3
8½	6·5	5·3	3·5
9	5·5	4·5	3·0
10	4·0	3·5	2·0

Description of Patents.

1. Process for the crystallisation, in motion and by cooling, of after-product masse-cuites boiled to grain in so far that the regulation of the supersaturation of the mother-syrup is carried out by the addition of water, which is applied in such a proportion that the quotient of supersaturation remains between 1·25 and 1·02.

2. Under the process of crystallisation in motion of after-product masse-cuites boiled to grain, for which an addition of water is provided, this addition commencing in the first place at approximately the vacuum temperature, and eventually in vacuum itself, either before or immediately after the filling out, so that from the beginning of crystallisation to the over-concentration of the mother-syrup the quotient of supersaturation may not exceed 1·25.—(*Oesterreichisch-Ungarische Zeitschrift für Zuckerindustrie.*)

Switzerland.

About £27,000 worth of sugar goods and candied fruit were imported in 1901, of which £8,000 worth came from the United Kingdom.

Crete.

Sugar to the value of £5,600 was imported into Candia during 1901, The total imports of sugar for the whole island were estimated at 1,114 tons, of the value of £19,170. Practically all of it came from Austria-Hungary.

Eastern Coast of Red Sea.

The consumption of sugar is growing more popular, though the increase is but slight. Egyptian sugar will probably before long be the only kind to be procured here; there is reason to anticipate that the crystallised sugar of Mauritius is losing ground, and although Austrian sugar has been lately pushed ahead slightly, it must eventually fall off as soon as the Brussels Convention takes effect.

Imports of sugar for three years 1899-1901 :—

		Egyptian.		Mauritius.	
		Quantity.	Value. £.	Quantity.	Value £.
1901	Cases	23,500	41,500	....	....
	Bags	21,900	38,850	5,980	5,800
1900	Cases	23,000	41,000	....	....
	Bags	19,600	29,900	6,300	6,300
1899	Cases	21,600	38,800	....	....
	Bags	19,000	28,500	5,320	5,320

Japan.

Kobe and District.—There was an increase in the sugar import amounting to nearly 12% in quantity and over 19% in value, the intake of the two ports being 97,320 tons in 1901, as against 87,070 tons the year before. More than half of this was refined sugar, brought to Kobe, and somewhat less than half was raw sugar, divided between Kobe and Osaka. Practically the whole of the Osaka import, amounting to 24,840 tons, most of it Java, under 14 Dutch standard, was really unrefined brown sugar, intended to be refined at the Osaka works, whilst of the so-called brown sugar imported at Kobe, amounting to 20,620 tons, a considerable quantity was not really raw sugar, but was roughly refined, being of a low grade and yellowish colour, which was classed by the customs as brown under a lower duty than white sugar.

The increase in the import of this staple was not wholly due to larger demand for consumption, but was stimulated by the imposition of a new consumption tax varying from 1 yen (2s. 0½d.) to 2 yen 80 sen (5s. 7d.) per picul, according to grades, of which there were

four, upon all sugars imported after October 1st last. In anticipation of this fresh burden, heavy importations were made in August and September, a great part of which was carried over to this year's stock. As regards the import of Continental beet sugar into Japan generally, it may be of interest to note that the Austro-Hungarian product, which was very nearly equal to the German in 1900, fell to less than one-half in 1901 :—

	Quantity.	
	1901.	1900.
	Tons.	Tons.
German	70,824	28,447
Austro-Hungarian	33,300	26,075

In 1901 Kobe's import of sugar was over 35% of the whole import of Japan, whereas in 1900 it was over 37%. The proportionate decrease is partly due to the increased import at Shimonosaki (Bakan).

Imports of sugar into Osaka and Kobe :—

	1901.		1900.	
	Tons.	£.	Tons.	£
Sugar	45,465	489,939	44,527	457,450
Refined	51,274	703,809	40,731	541,031
Sundry	579	1,591	1,810	3,733
Total	97,319	1,195,339	87,068	1,002,214

Persia.

Khorassan and Sistan.—Sugar is Russia's chief import. It is an article which, owing to the Persian's love of sweetmeats and to the extraordinary quantity which he is in the habit of using in his tea, finds an excellent market throughout the country. The value of Russian sugar imported into Khorassan and Sistan during 1901-02 was £144,625, or more than 40 per cent. of Russia's total importation. In 1900-1901 it amounted to £126,291.

Sugar to the value of £450 was exported to Afghanistan during the year 1901-02, as compared with £5,707 in the previous season. About £1,000 worth of loaf sugar was imported into Sistan from India during 1901-02. The loaves weighed 4 lbs. each.

Egypt.

There was an increase of more than £7,000 in imports of refined sugar during 1901. Nearly all came from Austria-Hungary and Russia.

There was a falling-off in the quantity and value of cane sugar exported from Alexandria in 1901.

The total quantity amounted to 41,187 tons, valued at £461,505, against 47,736 tons valued at £521,789, in 1900. The greater part of the quantity exported went to the United States.

During the first five months of 1902 there was a still more marked diminution, the quantity exported being 15,195 tons, valued at £118,590, against 24,480 tons, valued at £269,566, during the corresponding period of 1901, a falling-off of 9,285 tons and £150,976. The decrease in value was chiefly due to the lower prices which prevailed. Experiments in the cultivation of sugar beets are being continued, but the results have not so far proved satisfactory.

Brazil.

In 1901 sugar to the value of £147,570 was exported to the United Kingdom.

PUBLICATIONS RECEIVED.

Report on the Geology of Louisiana made under the Direction of the *Baton Rouge* Sugar Experiment Station. Baton Rouge, La.

A rather large volume, this forms a series of papers by different authors, based on the work of three field seasons, 1900, 1901, 1902, of geological surveying in Louisiana under the direction of Dr. Stubbs. The papers include "The Tertiary Geology of the Mississippi Embayment," "Improvements in Louisiana Cartography," "The Subterranean Waters of Louisiana," and "Oil in Louisiana." There are a large number of full page illustrations from photos, and one of them contains about the most remarkable case of water reflection we ever saw. The foreground represents a pool, but which side is right side up can only be ascertained by very close inspection.

About the most elaborate catalogue of sugar machinery that we have yet seen is that of Messrs. Pott, Cassels, & Williamson, the well known makers of centrifugals. Printed on art paper and having over a hundred pages of descriptive matter, all profusely illustrated, it forms an admirable guide for the would-be purchaser. Centrifugals take up most of the space, and they are shown in all patterns and sizes, electric, belt, or direct steam drive. We particularly note the ingenious method of dispensing with rheostats in the electric motor. The motor spindle runs loose, but on starting it, the centrifugal force generated through several radiating arms presses friction clutches against the inside rim of a pulley keyed direct to a basket spindle; by this means the load is gradually picked up. It is interesting to note that the same kind of device is being adopted for the friction clutch of motor cars.

Correspondence.

NINE-ROLLER MILLS.

To the Editor of "The International Sugar Journal."

Dear Sir,—In your February issue we have noticed a short article headed "Sugar Machinery," in which reference is made to a nine-roller mill made in America, and recently put down on a plantation in Demerara. This mill you state had to be purchased from America, because "no British firm had ever made one, and therefore had not patterns in stock." As this statement is somewhat misleading, will you allow us to point out that the nine-roller mill referred to simply consists of three three-roller mills of the usual power placed tandem fashion, and close up to one another on one bedplate, and driven by means of a single engine through the necessary gearing wheels. It will be readily understood that no special patterns are required for the manufacture of such a mill. Now, as to the remark that no British firm has ever made such a mill, we would explain that this firm (and doubtless many of our competitors) have turned out plants very similar to the one in question, and should have had no hesitation in undertaking its manufacture. As a matter of fact, we have during the last two or three years given several tenders for similar plants. Knowing this, we cannot accept your statement as to the reason for the purchase of the mill from the States. We have some recollection of some months ago seeing in a Demerara paper an account of an interview with a representative of the firm who have purchased the American mill, in which that gentleman suggested that his firm were inclined to purchase American machinery, because America was practically the only market for their sugar. In the near future the long hoped for abolition of the iniquitous sugar bounties will render the British cane sugar producer more independent of America, and, further, as that country will in all probability procure all the sugar she requires to import from Cuba, Porto Rico, &c., another market for sugar produced in other than American colonies will be imperative.

Yours faithfully,

George Fletcher & Co.,
H. Marsh. Manager.

[We readily publish this letter, but knowing some of the particulars of the case, we see little reason to go back from what we stated in our February editorial. In this particular instance, the orders for the machinery were given out by an English firm, who were interested in the factory for which the plant was destined, and it is safe to say that had they been satisfied with the design and working of British nine-roller mills, they would not have given the order to an American firm; but they, rightly or wrongly, came to the conclusion that no

English firm could make any mill to their exact requirements, and on the other hand they had satisfied themselves from personal inspection that a well known type of American nine-roller mill would be the only safe investment. The question of America providing a "market for their sugar" had no weight whatever with them in coming to a decision. This, therefore, only goes to prove what we had feared, that in some kinds of sugar machinery the British engineers are getting behind their American confrères. No doubt one explanation of the latters' success is due to the very extensive demand for sugar machinery during the last five or ten years in the American colonies (Cuba, Hawaii, &c.), which has enabled more elaborate designs to be evolved and put to work, whereas in our own colonies more or less of a stagnation has reigned, and orders for new and up-to-date machinery have been few and far between. Now that a different state of affairs is to be looked for in the near future, orders may be expected to come in, but unless our engineers are on the alert with up-to-date designs, they may suffer the mortification of seeing the orders secured by their American rivals. Happily we think that in most designs they are quite up to the best American standard, if not superior in some cases, but the competition may prove very severe in the not distant future, and it is as well to be prepared for it.—*Ed. I.S.J.*]

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. Thompson, C.E., F.C.S., M.I.M.E., Chartered Patent Agent, 6, Lord Street, Liverpool; and 322, High Holborn, London.

ENGLISH.—APPLICATIONS.

1046. G. W. Barratt, F. Barratt, A. Barratt, and J. B. Stennett, London. *Improvements in and relating to means for manipulating "boils," or masses of boiled sugar in the manufacture of sweets.* 15th January, 1903.

1415. E. W. Barratt, London. *Improvements relating to the manufacture of sweetmeats and similar articles of confectionery.* 20th January, 1903.

ABRIDGMENTS.

24569. C. A. Spreckels, and C. A. Kern, New York, United States of America. *Improvements in the purification of sugar bearing materials, and cleansing compositions for that purpose.* 3rd December, 1901. The method consists in obtaining purified sugar liquor from a mixture containing fluid sugar bearing material and sulphonated cleansing agent, and also in adding material which coagulates the said cleansing agent, and then separating purified sugar liquor from the mass.

GERMAN.—ABRIDGMENTS.

134194. Ludwig Fuchs, of Lundenburg, Moravia. *A sugar mashing device having two or more stirrers and a container composed of*

two adjacent cylindrical troughs. 6th September, 1901. Beneath the places where the two cylindrical bottom troughs meet one another, hollow bodies are arranged which are connected with the interior of the mash-pan by openings, and may be employed for drawing off the mother liquor from the crystallised masse-cuite and syrup, when the apparatus is used for second crystallisation, or for refining masse-cuite or raw sugar.

135312. W. H. UHLAND, Leipzig-Gohlis. *An apparatus for the constant separation of starch from liquid containing crude or impure starch.* 31st January, 1899. In a vessel which at the bottom tapers to a point, and is of suitable size and shape, a conically enlarging pipe having an internal introduction pipe is immersed down nearly to a bell placed over the lowest point of the vessel. The starch milk introduced by the inlet pipe is in consequence of this arrangement diverted radially, and the water rises slowly upwards outside the tapering or conical pipe, and flows away above through a nozzle. Under the bell a stirring mechanism is arranged, in order to prevent the highly concentrated starch, which is separated out, settling, by means of a slow movement of the stirring mechanism, and thereby to allow of a constant discharge of the starch through a suitable tap in the bottom. Combinations of several such mechanisms, one above the other, or side by side, serve for completely purifying in a continuous process the concentrated starch milk separated off, or the concentrated residues separated off by their mixture with fresh water and a renewed separation.

135607. DOMINIK SPANHEL and GEORG MEKWA, Lundenburg, Moravia. *A device for packing cube sugar.* 5th December, 1901. In this packing device for cube sugar, the sugar cubes coming from the slicing machine are received on a revolubly mounted plate. A cover is fitted in a horizontal position on this plate, which, after receiving the sugar cubes and being rotated into an almost vertical position, is introduced into the inclined forwarding case or box through the upper opening of the latter and there discharged.

Copies of all published specifications with their drawings in these lists can be obtained from W. P. Thompson & Co., 6, Lord Street, Liverpool, at One Shilling a copy for English or American Patents, and Two Shillings for German. In ordering please give number and date.

IMPORTS AND EXPORTS OF SUGAR (UNITED KINGDOM),

To end of January, 1902 and 1903.

IMPORTS.

Raw Sugars.	Quantities.		Values.	
	1901.	1902.	1901.	1902.
	Cwts.	Cwts.	£	£
Germany	925,577	343,740	351,951	129,052
Holland	58,873	26,856	20,384	10,208
Belgium	145,967	130,674	56,878	53,820
France	525,799	3,852	211,277	1,926
Austria-Hungary	21,150	355,643	7,925	153,183
Java	....	....	....	....
Philippine Islands	....	....	....	....
Peru	17,681	20,541	6,239	7,400
Brazil	21,125	17,525	7,657	6,875
Argentine Republic	103,748	38,799	43,381	16,855
Mauritius	....	651	....	320
British East Indies	17,119	30,467	7,944	10,733
Br. W. Indies, Guiana, &c.	83,110	31,316	52,633	21,105
Other Countries	16,250	42,632	6,614	18,062
Total Raw Sugars	1,936,399	1,042,696	772,883	429,539
Refined Sugars.				
Germany	2,250,494	1,030,672	1,224,931	532,856
Holland	444,987	182,717	263,856	107,498
Belgium	43,343	7,970	24,797	4,611
France	865,167	57,692	443,396	32,876
Other Countries	44	135,501	63	69,016
Total Refined Sugars	3,604,035	1,414,552	1,957,043	746,857
Molasses	101,965	148,870	22,743	29,546
Total Imports	5,642,399	2,606,118	2,752,669	1,205,942

EXPORTS.

British Refined Sugars.	Cwts.	Cwts.	£	£
Sweden and Norway	2,537	1,625	1,622	862
Denmark	5,326	6,774	3,018	3,358
Holland	2,335	5,356	1,238	2,927
Belgium	450	1,168	214	520
Portugal, Azores, &c.	949	436	506	200
Italy	1,040	1,058	504	490
Other Countries	31,531	22,850	20,243	14,430
	44,168	39,207	27,345	22,787
Foreign & Colonial Sugars.				
Refined and Candy	2,061	1,667	1,429	1,177
Unrefined	6,419	3,148	3,410	1,633
Molasses	145	12	48	12
Total Exports	52,793	44,034	32,232	25,609

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1903. Tons.		1902. Tons.
Total Receipts, 1st Jan. to Feb. 11th....	128,986	..	126,599
Receipts of Refined ,, ,, ,, ..	212	..	1,728
Deliveries ,, ,, ,, ..	126,980	..	142,561
Consumption (4 Ports, Exports deducted) since 1st January	142,615	..	171,057
Importers' Stocks (4 Ports) Feb. 11th ..	6,391	..	9,349
Total Stocks, Feb. 25th	153,000	..	83,549
Stocks in Cuba	203,000	..	241,500
	1902.		1901.
Total Consumption for twelve months ..	2,566,108	..	2,372,316

CUBA.

STATEMENT OF EXPORTS AND STOCKS OF SUGAR, 1902 AND 1903.

(Tons of 2,240lbs.)	1902. Tons.		1903. Tons.
Exports	25,738	..	33,989
Stocks	140,178	..	137,651
	165,916	..	171,640
Local Consumption (one month)..	3,750	..	3,700
	169,666		175,340
Stock on 1st January (old crop)	19,873	..	42,530
Receipts at Ports up to 31st January ..	149,793	...	132,810

JOAQUIN GUMA.

Havana, 31st January, 1903.

UNITED KINGDOM.

STATEMENT OF IMPORTS, EXPORTS, AND CONSUMPTION FOR THREE YEARS.
From *Produce Markets' Review.*

SUGAR.	Imports. 1903. Tons.		1902. Tons.		1901. Tons.	Exports (Foreign). 1903. Tons.		1902. Tons.		1901. Tons.
Refined, Jan. 1st to 31st	70.728	..	180,202	..	83.531	83	..	103	..	344
Raw, ,, ,, ...	52.135	..	96,820	..	59,302	157	..	321	..	535
Molasses, ,, ,, ...	7,443	..	5,098	..	8,743	—	..	7	..	271
Total	130,306	..	282,120	..	151,576	240	..	431	..	1,150

HOME CONSUMPTION.

	1903. Tons.		1902. Tons.		1901 Tons.
Refined, Jan. 1st to 31st.............	64,276	....	185,592	....	—
Raw, ,, ,, ...	41,459	....	113,563	....	—
Molasses, ,, ,, ...	6,292	....	7,196	....	—
Total	112,027	....	306 351	....	—
Less Exports of British Refined	1,960	....	2,208	....	—
Net Home Consumption of Sugar	110,067	....	304,143	....	147,189*

* Trade estimate.

STOCKS OF SUGAR IN EUROPE AT UNEVEN DATES, FEBRUARY 1ST TO 25TH, COMPARED WITH PREVIOUS YEARS.

IN THOUSANDS OF TONS, TO THE NEAREST THOUSAND.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	TOTAL 1903.
124	1300	811	636	280	3152

	1902.	1901.	1900.	1899.
Totals	3370 ..	2658 ..	2556 ..	2467

TWELVE MONTHS' CONSUMPTION OF SUGAR IN EUROPE FOR THREE YEARS, ENDING JANUARY 31ST, IN THOUSANDS OF TONS.

Great Britain.	Germany.	France.	Austria.	Holland, Belgium, &c.	Total 1902-03.	Total 1901-02.	Total 1900-01.
1559	847	552	403	540	3903	4195	4125

ESTIMATED CROP OF BEETROOT SUGAR ON THE CONTINENT OF EUROPE FOR THE CURRENT CAMPAIGN, COMPARED WITH THE ACTUAL CROP OF THE THREE PREVIOUS CAMPAIGNS.

(From Licht's Monthly Circular.)

	1902-1903. Tons.	1901-1902. Tons.	1900-1901. Tons.	1899-1900. Tons.
Germany	1,750,000 ..	2,299,408 ..	1,984,186 ..	1,798,631
Austria	1,070,000 ..	1,302,038 ..	1,094,043 ..	1,108,007
France	890,000 ..	1,183,420 ..	1,170,332 ..	977,850
Russia	1,215,000 ..	1,110,000 ..	918,838 ..	905,737
Belgium	230,000 ..	350,000 ..	393,119 ..	302,865
Holland	105,000 ..	203,172 ..	178,081 ..	171,029
Other Countries .	345,000 ..	400,000 ..	367,919 ..	253,929
	5,605,000	6,843,038	6,046,518	5,518,048

THE

INTERNATIONAL SUGAR JOURNAL.

No. 52. APRIL, 1903. Vol. V.

☞ All communications to be addressed to The Editor, Office of *The Sugar Cane*, Altrincham, near Manchester.

All Advertisements to be sent *direct*.

Cheques and Postal Orders to be made payable to Norman Rodger, Manchester.

☞ The Editor is not responsible for statements or opinions contained in articles which are signed, or the source of which is named.

Blyth Bros. & Co., Mauritius, report shipments of sugar from August 1st to 6th February as 81,796 tons, against 75,476 tons in the corresponding period of 1901-1902.

Dividends of German Refineries.

The Frankenthal refinery, with a capital of mks. 6,000,000, and having under its control two sugar factories, lately realized a profit of over mks. 2,800,000, which permitted a dividend of 25% to be paid. The Rositz refinery, which works residuum molasses by the strontia process, paid 9% on a capital of mks. 5,200,000. There are numerous other examples where the profits varied from 10 to 20%. It is evident, however, that the Cartels are of greater benefit to the refiners than to the raw sugar manufacturers.

Sustaining Power of Demerara Sugar.

In a recently published book on travels in South America by Sir Martin Conway, he gives a valuable testimonial as to the sustaining powers of real Demerara sugar. He says: "At higher levels only light foods can be eaten with advantage. . . . . More important, perhaps, than all these was a great tin of coarse brown Demerara sugar, the finest heat-producing, muscle-nourishing food in the world. For men taking violent exercises, such as soldiers on active service or athletes in training, a plentiful supply of sugar is far better than large meat rations. A quarter of a pound per man per day is my allowance on the mountain side, and I am inclined to think it might be increased to nearly half a pound with advantage, cane sugar being, of course, selected for the purpose."

THE NEW GOVERNMENT CARTEL IN AUSTRIA-HUNGARY.

The importance of Austrian sugar in the world's supplies is well shown in the following table:—

EXPORTS OF SUGAR FROM AUSTRIA-HUNGARY.

	Refined. Tons.	Raw. Tons.	Total in Raw. Tons.
Ten years, 1864-1873	150,668	233,635	401,044
	42%	58%	
,, ,, 1874-1883	670,754	1,062,092	1,807,374
	42%	58%	
,, ,, 1884-1893	1,885,719	1,402,232	3,497,475
	60%	40%	
Nine ,, 1894-1902	4,237,807	827,118	5,535,798
	86%	14%	

The increase is in great measure due to bounties, and during recent years more especially to the Cartel bounty. The increased exportation of refined as compared with raw is due to the larger bounty, introduced some years ago, on refined sugar; and more recently to the greater share of profit derived by the refiners from the Cartel bounty.

In 1901, the exports were 628,115 tons of refined sugar, and 74,388 tons of raw. In 1902, the figures were, refined, 613,285; raw, 60.951.

Of this quantity of refined, 200,100 tons were exported from Trieste, and 127,500 tons from Fiume, leaving 285,685 tons which must have been exported via Hamburg.

The Cartels in Austria and Germany, by stimulating a great over-production, depressed prices in 1902 to 6/- and 7/6, f.o.b. Hamburg for raw and refined sugar, and brought about the crisis which greatly contributed to the success of the Brussels Conference and the ratification of the International Convention.

In spite of this fact the Austro-Hungarian Government now think proper to organise a cartel by actual legislation, and to thus compel the sugar industry of those countries to combine for the purpose of extracting from the Austrian consumer an extra profit of nearly 6 francs per 100 kilos. The fund thus created will enable them to sell the 750,000 tons, which they must export, at an advantage over all competitors.

The question naturally arises whether this action on the part of the Austrian Government is in conformity with the terms of the Convention.

The new law begins by estimating the consumption of Austria at 277,034 tons, and that of Hungary at 86,366 tons; total, 363,400 tons. Elaborate arrangements are then laid down for dividing this con-

sumption among the various raw sugar factories and refineries of the Empire. The share, or "contingent," of each factory and refinery is carefully calculated, preference being given to the smaller establishments, so that they may not be crushed by the lower cost of production of the larger factories. No new factories are to be established unless they are at least 100 kilometers distant from the nearest factory, and the owners of the new factory must grow their own roots. The building of new refineries will be no longer permitted.

Each factory is allowed to sell its share (of course at a great premium) to some other factory which may be more conveniently situated for the supply of home consumption. Thus, a factory may work entirely for export and yet enjoy its share of the extra 6 francs which the new law forces from the consumer.

The first examination of this new law, and its bearings on the terms of the Convention, appeared in the *Sucrérie Belge* of the 15th February. From this it seems to have been subsequently decided that new factories are not to be compelled to be at a distance of 100 kilometers from existing factories, and that the Minister of Finance refuses to make any reduction in the consumption duty, even to the amount of the abolished direct bounty. The refiners have entered into an agreement with the manufacturers (fabricants) to give them 3 francs 46 per 100 kilos. out of the extra profit on home consumption sugar. The writer then proceeds as follows:—

"We have received from Mr. Martineau, Expert of the British Delegation at the Sugar Conference, a letter in which he asks whether the new Austrian law is in conformity with the Convention. The Brussels Conference, he points out, allowed a surtax of six francs. If the industry can form, under the protection of this surtax, a Cartel which may give them a certain advantage, they may perhaps be permitted to enjoy it. The expense of organizing and defending such an arrangement would, in this case, reduce the advantage to a very small figure.

"But if a Government like that of Austria creates an obligatory syndicate by legislative enactment there will be no expense for the industry, which will thus enjoy a very considerable new bounty. Mr. Martineau asks us whether we can regard such an organization as contrary to the terms of the Convention.

"We regret that we cannot share our correspondent's opinion much as we sympathise with it. It is true that the Powers have undertaken to abolish all bounties, direct or indirect, but the same article defines a bounty: "*f.* The advantages arising from any surtax higher than that fixed by Article III." This article therefore indirectly admits advantages resulting from any surtax lower than the limit thus fixed. Moreover, in Article IV. the amount of the countervailing duty on such a bounty is calculated after deducting from the surtax the normal amount of six francs. Unfortunately, therefore, there

appears to us to be no doubt as to the right of the Austro-Hungarian Government."

But in the following number of the *Sucrérie Belge* there appears a letter which puts quite a different complexion on the case, and is evidently written by one who has some authority for speaking.

He says:—

"The last number of the organ of the society of sugar manufacturers of Belgium announces that Mr. Martineau, technical member of the British Delegation at the Sugar Conference, has written stating his doubts as to the conformity of the recent Austrian sugar law with the International Sugar Convention. Mr. Martineau expresses the opinion that the creation by one of the contracting States of an obligatory Cartel binding its producers and dividing among them the profit of the six francs surtax is contrary to the terms of the Convention. . . . .

"The question thus raised must be regarded as one of considerable importance for all the signatory countries; it must be studied not only in reference to a single article of the Convention, but according to the texts of the principle laid down, the discussions of the Conference and the general spirit inspiring the resolutions of that assembly.

"Now, the first Article, in its first paragraph, fixes in general terms, precise and well weighed, the essential import of the international act accomplished at Brussels. It is well to re-call its terms: "The High Contracting Parties undertake to abolish, from the date of the putting in force of the present Convention, the bounties, direct and indirect, which the production or exportation of sugar may derive profit from, and *not to establish bounties* of that kind during the whole continuance of the said Convention." I underline the words: "*not to establish them*," which stand out from the text to throw light on a strict and serious determination, perfectly in harmony with the point raised by Mr. Martineau.

"If, armed with this text, we search in the discussions of the Conference for the thought which illumines and characterises it, we find it in almost every sitting developed as follows: The internal market belongs to each country, and in order to insure this monopoly a certain surtax is necessary; this surtax is not intended for the purpose of giving rise to bounties, but since it is impossible, without this impediment, to protect the internal market, it is inevitable, with the consequences that it may bring with it, consequences not desired but tolerated.

"There is a great difference, as you see, sir, between the international will thus defined and explained, and the official establishment by a Government, and at its cost, of a Cartel institution solely intended for the purpose of transforming into a State bounty the advantage of the surtax authorised by the Convention. I hasten to add that I indicate the problem, but that it is for the permanent Commission to give its

solution,—a Commission created by the Convention for the purpose of studying the eventual difficulties of its application, and which must meet on or before the 1st June. The sugar law of Austria-Hungary will undoubtedly form an object for its deliberations, as well as all other sugar legislations."

The next step in the discussion took place in the French Chamber, on the 28th February, when the Minister of Finance replied to questions raised by M. Ribot in reference to the sugar convention. The Minister said :—

"I can give you my opinion, but I have no power to enforce it. In my view, as in that of my honourable questioner, the system of allowing bounties to sugar which, placed in warehouses, will not be exported till after the 1st September, and also the system of legislative Cartels which M. Ribot has indicated to us, are contrary to the stipulations of the Convention."

The next opinion comes from Sir Nevile Lubbock in the course of an interview with the London correspondent of the *Neue Freie Presse* of Vienna.

"This system," he said, "is a Cartel, purely organised and directed by and at the cost of the State; it procures for the industry all the advantages of a Cartel, while the Government bears the cost. It also has this advantage, that no one can remain out of it. The Brussels Convention does not forbid private Cartels, but from the moment that the State intervenes the penal clause becomes applicable. For the moment there is no opportunity of discussing it diplomatically, but it is certain that the system of the contingent will be examined."

The firms interested in the Hamburg sugar trade have declared, in a letter of the 25th February, that, according to a paragraph in the international sugar contract in force since August, 1902, beetroot sugar subject to a countervailing duty in Great Britain or the United States cannot be accepted after the 31st July, 1903. This measure will apply to Austrian sugar if, in the opinion of the permanent Commission at Brussels, this sugar is regarded as receiving a bounty, or if it is charged with a countervailing duty in the United States. Consequently, after the 31st July, Austrian sugar may be excluded from delivery on Hamburg contracts, and in England the sugar will only be accepted on payment by the seller of an indemnity equal to the countervailing duty.

The course pursued in Germany with regard to this question is interesting and instructive. The *Deutsche Zuckerindustrie* tries to make out that the Austrian Government Cartel is consistent not only with the letter but also with the spirit of the Convention. The *Centralblatt für die Zuckerindustrie*, on the other hand, declares it to be contrary even to the letter of the Convention, because the Convention forbids all bounties, whatever form they may take, and the penalty defined in Article IV. being only a minimum, it is clear

that even a bounty obtained under the six francs surtax may be countervailed.

The Committee of the Society of the German Sugar Industry have petitioned the German Government for legislation similar to that of Austria-Hungary. But about 100 of the sugar manufacturers have protested against this policy. The Committee had adopted the decision by a majority of 25 to 9. Out of the 25, 13 were refiners and only 12 were manufacturers, some of whom changed their view after the meeting. So that it is doubtful whether even a majority of the manufacturers are in favour of the proposal. It was therefore desired that a general meeting should be held, and when the Committee refused, the President of the Society sent in his resignation.

Those who protest base their opposition on the grounds that a return to bounties now that they have been abolished by international arrangement would be undesirable and would hinder the development of the industry; that the proposed legislation would be contrary to the spirit of the Convention, and would tend to re-establish the bounty system; that such a Cartel would hinder the progress of consumption and delay a further reduction of duty; that the surtax of six francs is sufficient to keep out Austrian sugar, the competition in outside markets being in the meantime counterbalanced by the extra duty which the United States and British India will levy against it; that Austrian sugar will not be acccepted on international contracts; and, finally, that if Germany were to follow the example of Austria, a fall in the price of sugar would destroy any advantage to be derived from the new bounty, while the artificial raising of the price to the German consumer would attract importations from neighbouring countries. It is evident that the sugar industry in Germany is quite disposed now to take an enlightened view of the economic aspect of the position.

In the Reichstag, on the 6th March, Baron von Thielmann, Secretary of State, replying to an interpellation of Count Carmer, said that there was by no means a unanimous demand on the part of the sugar industry for the system of the "Contingent." If Germany were to follow the example of Austria it would be equivalent to prohibiting the erection of new factories. Moreover, America is evidently watching Austria and will levy a duty against her sugar as obtaining an indirect bounty. He then quoted the opinions of Sir Nevile Lubbock and of M. Rouvier, the French Minister of Finance, and concluded by declining to propose the system of contingents.

M. Paasche (National Liberal) declared the system to be contrary to the spirit of the Convention, and said that the industry asked for no help from the State except by such a reduction of the duty as would stimulate an increase in the consumption. Another member asked for a reduction of railway and canal rates as well as a reduction of duty, and the Minister replied that next week a Bill on the subject would be brought in.

M. Yves Guyot, in the *Siècle*, declares that the Austrian legislation does not threaten any very serious danger, but it shows the advantage of the permanent Commission at Brussels, which, in his opinion, will declare by a very large majority that countervailing duties are applicable to legislative Cartels.

In Austria-Hungary itself, the new legislation is giving rise to some friction. Hungary threatens that if the permanent Commission condemns the measure she will immediately levy a surtax of six francs on Austrian sugar, in order to maintain intact the right to supply by means of its own sugar industry the whole Hungarian consumption. On the 17th March, in the Austrian Chamber, Dr. Bärnreither, leader of the constitutional German landed proprietors of Bohemia, in speaking on the subject of the Austro-Hungarian Compact, said he regarded the sugar arrangement as one of the principal troubles. He objected to a speech recently made in the Upper Chamber by Count Khevenhüller (Austrian Delegate at the Brussels Conference), who had expressed doubts as to the legitimacy of the Austro-Hungarian allotment system in the eyes of the Brussels Sugar Commission. Dr. Bärnreither complained that the Austro-Hungarian system had been falsely interpreted at home and abroad, especially abroad, and that even the German Minister, Baron von Thielmann, had misunderstood its scope and character. The whole agitation against the allotment system Dr. Bärnreither attributed to the influence of a certain group of sugar industrialists whose one-sided profits the system curtails.

It is evident that there is considerable difference of opinion even in Austria, and that Count Khevenhüller, who, as Austrian Minister at Brussels, and Delegate at the Conference, must be a pretty good judge of the question, has strong doubts of the legality of the recent legislation and considerable fears as to the action of the permanent Commission.

The most recent act of the Austrian Government is to bring in another Bill, laying down stringent regulations with regard to the purchase of roots from the farmers, fixing a minimum price and punishing with fine or imprisonment any improper acts or intimidation for the purpose of depressing the value of roots. The Government are determined that the farmers shall have a fair share of the five or six francs bounty which is to result from the recent legislation.

The percentage imports of beet and cane sugar, respectively, into the United Kingdom during 1902 are estimated as follows:—

Beet	92·04
Cane	7·96
	100·00

MEMORANDUM ON THE SUGAR PRODUCTION OF THE WORLD.

By Sir N. Lubbock.

The total production for the last two years may be taken as follows:—

	Tons. 1901-2.		Tons. 1902-3.
European beet, except Russia	5,722,000	..	4,390,000
Russia	1,099,000	..	1,215,000
British Colonies	545,500	..	513,000
Egypt	96,000	.	90,000
India	3,000,000	..	3,000,000
United States, Cuba, Porto Rico, Manila, and Hawaii	1,804,500	..	1,920,000
Peru, Argentine, St. Domingo, Mexico, and Brazil	738,500	..	582,500
Java	767,000	..	842,500
French Colonies	110,000	..	104,000
	13,882,500		12,657,000

Of this:—

The Indian production is required for Indian consumption	3,000,000	..	3,000,000
Russian production is required for Russia and Asia	1,099,000	..	1,215,000
United States, Cuba, Porto Rico, Manila, and Hawaii, for United States	1,804,500	..	1,920,000
Beet for European consumption, exclusive of United Kingdom	2,656,000	..	2,750,000
	8,559,500		8,885,000

There remains available for United Kingdom and other countries:—

Beet in Europe	3,066,000	..	1,640,000
British Colonies	545,500	..	513,000
Egypt	96,000	..	90,000
Peru, Argentine, St. Domingo, Mexico, and Brazil	738,500	..	582,500
Java	767,000	..	842,500
French Colonies	110,000	..	104,000
	5,323,000		3,772,000

Dissecting these items :—

Beet in Europe available for export from Austria and Germany	2,115,000	..	1,590,000
British Colonies :—			
The Mauritius crop goes to India	147,000	..	140,000
Queensland and Fiji to Australia	151,000	..	110,000
West India to United States	200,000	..	210,000
,, United Kingdom	47,000	..	53,000
	545,000		513,000

The remaining cane production is available for United Kingdom consumption.

Thus we have of beet and cane sugar available for supply of United Kingdom :—

Beet :			
Germany and Austria	2,115,000	..	1,590,000
Other	951,000	..	50,000
	3,066,000	..	1,640,000
Cane :			
British West Indies	247,000	..	263,000
Argentine, Peru, Brazil, St. Domingo, and Mexico	738,500	..	582,500
Egypt	96,000	..	90,000
Java	767,000	..	842,500
French Colonies	110,000	..	104,000
	1,958,500		1,882,000

If bounties were allowed to continue, the whole of this cane supply would be jeopardised, and it is evident that we should have, practically, to depend entirely on Germany and Austria.

On the other hand, the abolition of bounties keeps the door open to this large quantity of sugar.

These figures prove incontestably that the interest of the consumers of this country would have been most seriously compromised but for the Brussels Convention.

Exports from British Guiana, from January 1st to 9th March, 1903: sugar, 25,799 tons; rum, 848,527 gallons; molasses, 1,358 casks; molascuit, 83·5 tons; cocoa, 14,430 lbs.; against 30,816 tons; 1,055,854 gallons; 114 casks; 0 tons; and 26,656 lbs. respectively for the like period last year.

THE SUGAR CANE IN EGYPT.

By Walter Tiemann,

Member of the Society of German Sugar Technists and of the Assoc. des Chemistes de Sucreries, et Distilleries, Paris.

(Continued from page 133.)

IV. Manuring Mediums.

The stable dung forms the nearest available manure for the husbandman, and is extensively so used. It is, however, seldom produced in a proper manner. As a rule, no straw is given for a bed to the stable cattle (cows, buffaloes, horses, camels, and donkeys); they stand on the bare ground. Their solid excrements are in most cases dried by the Arabs for subsequent use as fuel, so that only the layer of earth soaked with urine, which from time to time is removed from the stable, remains as "manure." As a consequence it has not the value which the manure proper possesses. Only on a few farms in the delta could the writer discover any straw beneath the feet of the cattle, such as would go to form a valuable manure, and these cases were the exception rather than the rule.

Another commonly used manure is "ruins manure," *zebach adîm* and *zebach coufri*, which is the decomposed remains of old ruined settlements. These are the débris of mud huts, wherein the human and animal remains, and rubbish of past ages lies. The more ancient they are, the better will the *zebach adîm* be. It is necessary, though, to bring a large amount to the fields, say 100-150 camel loads per feddan in order to obtain sufficient results: and though this kind of manure costs nothing, yet owing to the expense of transport, the pecuniary gain therefrom is rather doubtful. This manure has a very good physical effect on the hard black ground, inasmuch as it loosens it, but this is a point almost unknown to the Arabs. Consisting in the main of decomposed sandy and limy matter, it contains plant food in very varying amounts. Nitrogen exists to the extent of from 0·1 to 0·5 %, though in isolated cases, where heaps of old dung and bones are found, 4 to 5 % nitrogen has been discovered. Potash and phosphoric acid are likewise present in varying quantities, as the following analysis averages show; the moisture was fixed for purposes of comparison at 5 %.

ANALYSES OF RUINS MANURES TAKEN FROM OLD MUD HUTS.

SOURCE.	Moisture	CaO.	K_2O.	Cl.	P_2O_5.	Organic Matter.	N.
	%						
Tel el Baste	5	2·74	1·35	0·55	0·5	6·12	0·207
Tel el Baste	5	2·91	1·27	0·57	0·72	5·39	0·214
Old Cairo	5	18·19	1·5	1·13	1·75	9·76	0·325
Old Cairo	5	14·1	3·08	2·92	1·25	13·5	0·49
Kiman Faris, Fayoum .	5	4·4	1·44	0·57	0·84	5·1	0·278
Tel el Takud, Damanhur ..	5	5·54	1·2	0·04	0·4	3·91	0·03
Kom Freen, Damanhur ..	5	1·65	0·71	0·64	0·1	4·18	0·126
Hikia	5	3·16	2·24	0·123	0·71	5·02	0·091
Halawat	5	3·78	1·3	2·04	0·19	10·97	0·365

As to *zebach balladi*, which consists of the rubbish of fallen dwellings that are known to be comparatively modern, the following analyses give some idea of composition :—

ANALYSES OF ZEBACH BALLADI.

SOURCE.	Moisture	CaO.	K_2O.	Cl.	P_2O_5.	Organic Matter.	N.
	%	%	%	%	%	%	%
Guizech	5	4·35	1·23	0·59	0·20	10·9	0·344
Lagarik	5	4·02	1·81	0·83	0·22	10·72	0·424
Charkieh.. ..	5	3·69	1·56	0·56	0·19	8·08	0·238
Fayoum	5	4·16	1·34	0·41	0·20	8·36	0·201
Galiubieh	5	2·64	1·04	0·91	0·21	10·64	0·301

All the above analyses were carried out at the Agricultural College, at Cairo, and can be taken as standard ones.

A much prized, and to some extent efficacious, manure is *dove guano*. This is obtained in various places, in Upper Egypt rather than in the delta, in specially built dove-houses, or dove lofts on the huts of the fellahs. In practice, it is generally used for garden or vegetable culture (melons, &c.); though we also find it employed for the large cultures, such as cotton, maize, second year cane, when the planter can obtain it from the Arab hamlets belonging to him, or otherwise cheaply, and is then employed with advantage.

An analysis of this guano yielded 3-4% nitrogen, 1·5 to 1·75% phosphoric acid, corresponding to 3-4 % phosphate.

An analysis made by the Agricultural College under 5% of moisture gave the following composition :—

	Per Cent.		Per Cent.
H_2O	= 5	P_2O_5	= 2·22
CaO	= 2·28	N	= 5·21
K_2O	= 2·7	Organic matter	=66·4
Cl	= 0·93		

According to these figures Egyptian guano is still inferior to the American variety. The price of good native dove guano is proportionately high, 40 piastres per ardeb. To obtain any results, a minimum of 3 ardebs per feddan will be required, corresponding to an outlay of about 57 Mk. per hectare (or 23s. per acre). The writer himself found no practical financial results to ensue from the use of Egyptian dove guano for field experiments with the sugar cane.

Isolated amongst the ancient stone crevices and hollows of the mummy tombs, *bat guano* is also to be found. It can be used as good manure in view of its containing phosphoric acid, but finds no general employment, since the spots where it may be obtained are mostly in the hills and not in the vicinity of the plantations. Its transport is too uncertain and costly for the fellah, as is frequently the case also with *zebach adîm*.

It can be said that *zebach adîm*, stable dung, and dove guano are the only manures available for the Arab cane planters in Upper Egypt. As to their value and effects, the indifferent Arab rarely keeps any record; he is content to do what his forefathers have done and no more. The cost of manuring varies from 20s. to 40s. per feddan, and the ultimate results depend largely on the more or less valuable local conditions of natural manuring.

As a kind of green manure, the growth of crops of clover, luzerne, beans, &c., can be undertaken. Even when these are not ploughed over as regular green manures, but are harvested, still plenty of the plants and roots remain on and in the ground, which latter is thereby enriched in humus and nitrogen. In the delta it is quite customary for the cotton planting to be preceded by a crop of clover which is used to recuperate and ameliorate the soil. This plan is adopted, if not everywhere, at least in Upper Egypt as a preliminary culture to the cane cultivation. It is extraordinary how widespread the knowledge of the Arabs is that leguminous plants collect nitrogen for use in the ground from the air. This explains also the circumstance that many Egyptian agriculturists believe cotton and first year cane require no manuring, whilst they consider manuring necessary for second year or ratoon canes, as by then the action of the unconscious green manures has ceased. Every big agriculturist knows that, following on clover, beans, &c., he can reckon on a normal crop of cane or cotton, and that on the other hand, when maize, durrah, *i.e.*, graminaceous plants, are sown as a preliminary crop, he must manure these well if he desires good results to follow, and that the manures employed for these crops (the culture of which lasts two

months) have an after-effect on the subsequent crops of cane or cotton as the case may be. By means of a well proportioned manuring of the preliminary crop, one can gain much. Specially noticeable as nitrogenous green manures, *soya hispida* (soya beans), $\frac{3}{4}$% nitrogen, and *arachis hypogea* (earth nuts), $\frac{1}{2}$%, act admirably as preliminary crops.

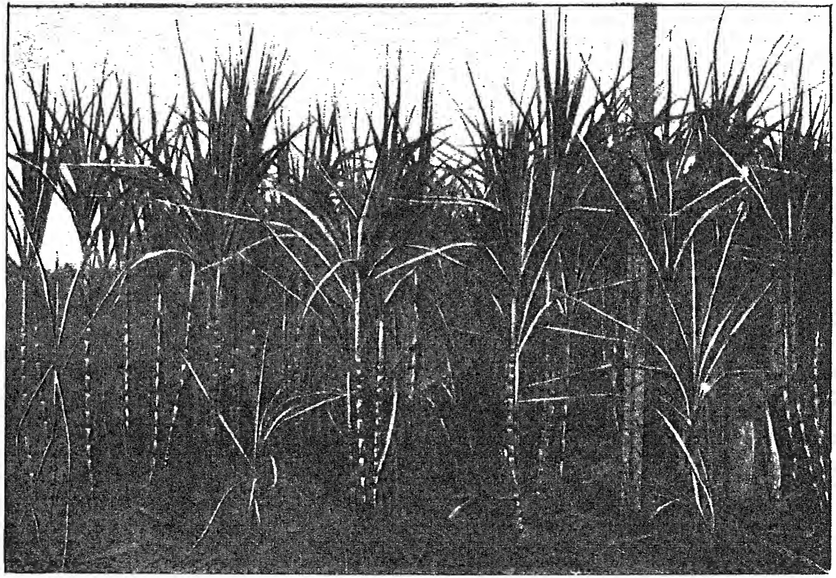
In recent times several phosphate beds have been discovered in Egypt. A detailed description of them is found in the Report on Phosphate Deposits in Egypt by the Geological Society at Cairo, 1900. These beds were found in different places; in the north of the Sinai peninsula, in Beharia and the eastern desert by Keneh, also in the south by the Dakhla oasis. Only that situated near Keneh can be seriously considered; the remainder are of little practical value, owing to the poor quality of the rock and its weak layers, but more still owing to the unfavourable isolation of the beds in the unpopulated desert. At Keneh they are 12 to 18 miles from the Nile. Their size varies from 0·07 to 0·19 metres thick. The colour is light grey to yellowish-brown, and the substance is formed from fossils (fish), coproliths, together with lime, iron and aluminium oxides. In the Keneh beds were found

$$11{\cdot}49\%\ P_2O_5 = 25{\cdot}09\%\ Ca_3(PO_4)_2$$

It is an insoluble crystalline mineral phosphate and might possibly be procured at small cost by transporting in a finely ground condition; its value in the experimental field is not yet established, and one can therefore say nothing about its actual effects. A change in super-phosphate is not a wise proceeding when the mineral contains at least 40% tri-calcium phosphate.

Besides the above quoted natural sources of manure for the land, the sugar manufacturer has the residue of the factory at his disposal for use in the fields. In his Java reports Kruger recommends spreading diluted molasses over the fields. Most of the refuse water of the cane fields passes direct into the flowing stream. The filtrated scum refuse is not of so much importance; good use can however be made of the bagasse or molasses ash for manuring. According to an analysis of Prinsen Geerligs of Java, the bagasse ash from the mills contains 1·82 to 2·4% P_2O_5, and 1·5 to 2·5% K_2O. The bagasse yields about 4% ash. Hence a loss per hectare of 6·3 to 11 kg. P_2O_5 and 5 to 10 kg. K_2O is involved. The bagasse ash of diffusion factories is of much less value as regards its proportion of K_2O and P_2O_5, owing to the chips having been washed and pressed out. In the cane diffusion process, a temperature of from 90° to 100°C is maintained. Consequently, the principal constituent of this ash is an almost pure silicate. In spite of its being insoluble, this ash is nevertheless specially suited for physically improving the Nile soil. Yet to the best of the writer's knowledge, he has never seen it taken out to the fields. In some places it is used as an ingredient in the preparation of mortar for building.

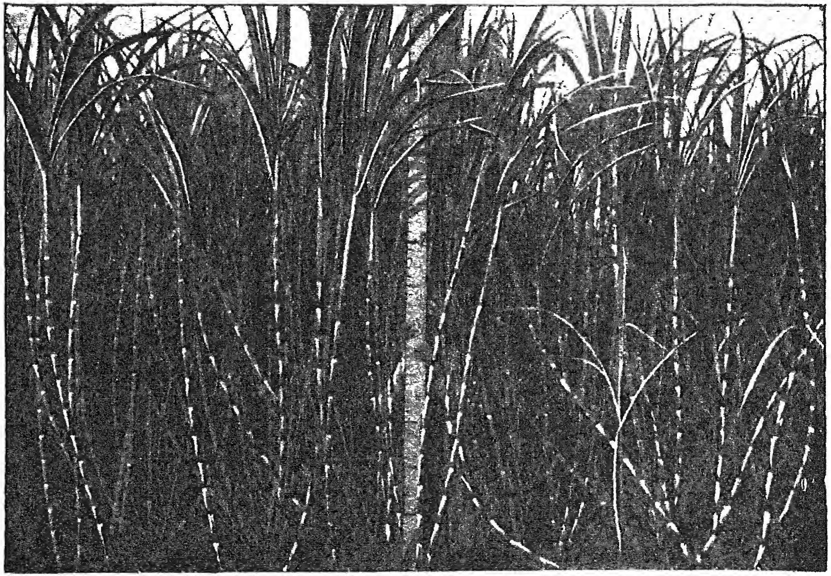
EXPERIMENTAL FIELD, 1898 (RATOON CANES).
(Not Manured.)



Weight of canes per hectare .. .. 27 metric tons.
,, ,, ,, acre.. .. .. 10·8 ,, ,,

EXPERIMENTAL FIELD, 1898 (Ratoon Canes.)

(Manured.)



Manure per hectare	400 kgr. nitrate of soda (352 lbs. avoird. per acre).
Weight of canes per hectare	55 metric tons.
,, ,, ,, acre	22 ,, ,,

Mixing the bagasse with molasses for burning is not good practice, as owing to the presence of the above mentioned minerals, SiO_2 and K_2O, a glassy clinker is formed which chokes up the firegrates, and practically yields no ash as a result of the combination.

Where the molasses alone are made use of for fuel a rich potassic ash results which forms a good substitute for potash in manuring the cane fields. According to an analysis of Lokeren-Campagne, the ash from the Egyptian molasses is composed as follows:—

		Per Cent.			Per Cent.
Insoluble in HCl	..	= 7·3	Soluble in HCl	CO_2	= 21·2
Soluble in HCl	P_2O_5	= 1·6	,, ,,	SiO_2	= 2·0
,, ,,	K_2O	= 40·3	Total..	.. SiO_2	= 4·0
,, ,,	CaO	= 5·5			

The masses of leaves remaining behind on the field at harvest time are generally burnt on the spot, if not previously appropriated by the labourers and their kin as fuel for the cold season of the year, or else burnt in the lime kilns. Working them in with a plough is not feasible in the case of large masses of leaves, each three feet long. It would be a good plan to use them as straw for the cattle to lie on, and for "compost" manure, but strange to say, the writer has not yet seen this plan adopted. The burning, which is the general custom, has the advantage of promptly clearing the fields, and also of preventing the outbreak of bacteria, and of exterminating sundry insect pests. Owing to the high price of fuel in Egypt, the factories have found out in the last few years the great heating value of dry cane leaves, and by means of steam presses have started making them up into compact and easily transported masses of fuel. The value of the ashes as manure is comparatively small, but as "compost" the leaves prove of good service.

V. Manuring of the Sugar Cane.

For a normally good success in field cultivation, all the required conditions must be present, and exercise a joint action. Accurate choice of ground, sufficiency of light, air, heat, and water, and last but not least a specially good planting material, produced by selection, as well as a judicious and careful manuring, are all of paramount importance. The particular weather conditions have a very great influence on the crop, but the husbandman can do little to prevent this, save by choosing sheltered situations, or by hedging in his fields. The problem before the planter consists in improving the conditions which lie within his powers and depend on his skill and knowledge.

First of all, a careful working up of the soil is necessary. Where hitherto the customary ploughing of the fellahs has barely turned the soil, one should on the contrary have the ground completely turned over by means of modern ploughs. In this proper turning over of the soil lies the real task, as it ensures a physical and chemical treatment

to, and loosening of, the subsoil. Next a careful choice of planting material, whether from seed or cuttings, is the second point for the planter's consideration. What results can be achieved thereby is shown from the Egyptian cotton industry, which to a very large extent holds the first place in the world's market as regards quality. Unfortunately this claim does not extend to the other large cultures of Egypt. Yet most important results can be obtained from the sugar cane for example, as experiments carried out for several years with that object have shown. It involves a comparatively easy method of work that entails little cost and only requires intelligent attention and care. The third chief point is the cultivation and rearing of the plants by means of suitable manuring, thus maintaining the fertility of the soil. There are very few plants which can live solely on air, water, and soil without constant applications of plant food material or its equivalent. For the ambitious cultivation of cane on a large scale, the question of manuring is about the most weighty one. Even the the best soil, with progressive culture, becomes unprofitable and unfruitful in a short while. The crops no longer pay the possessor or tenant for his ground rents, rates, and taxes. In other countries science has been working for a long time at the solution of the question. Can we succeed in getting more out of a given area than we have hitherto done? In any case the plants will demand a good soil. And such a good and fruitful soil we can provide ourselves with if we carry out the task carefully, employing the most practical instruments, and most suitable manures. The question then becomes: What manures should we employ? Stable dung, natural "compost" manure, or artificial chemical manures? The answer is, use all together, so as to achieve the best results. Stable dung and "compost" manure can always be used, yet do not sufficiently fulfil the claims of a nutriment, and in tropical and sub-tropical regions, such as Egypt, are not available in sufficient quantities. In artificial manures it is possible to have the three indispensable plant nutriments in properly proportioned quantities according to one's requirements. The artificial manures consist of nitrogen, phosphoric acid, potash, and mixed manures. With artificial manure and stable dung mixed together, the agriculturist will be in a position to double the crop output he has hitherto obtained, and in time Egyptian agriculturists will be really induced for the sake of success to carry out their work with more care and attention, without the noted *malesh* and *bukrah*,* and he who begins first will hold an advantage over his lazier neighbours. In the previous chapter it was shown what manuring mediums the planter had at his disposal in the country itself. The question now suggests itself whether the planter can supply the soil with its needed nutriments from these cited mediums, so as to obtain a rich harvest

**Malesh* and *bukrah* are two generally used Arabic words; *malesh* = never mind; *bukrah* = to-morrow.

on a par with those in other cane growing countries. This is clearly not the case. The average crop of 550 to 600 cantars of cane per feddan, and every statistical comparison with other tropical and sub-tropical countries, show the difference and deterioration in Egyptian results. Only from the view of a momentary profit, is the ground drained by crops year after year without proper replenishing. In countries where unrestricted areas of ground are at one's disposal, and fresh tracts of virgin soil can be placed under culture, abandoning that portion which has become unfruitful, this may be excused, but in Egypt it is out of question owing to the limited strips of fertile soil, the high prices of land, and the dear rents. Without rational manuring, the profitable production of large cultures is no longer to be thought of in Egypt; and the sugar cane is one of the most exacting of large cultures. If we take an average normal crop of 60,000 kg. of cane per hectar, then this drains from the ground in the course of a season the following plant nutriments :—

	Weight of Crop.		N.	P_2O_5.	SO_3.	Cl.
	Fresh.	Dry.				
	Kgr.	Kgr.	Kgr.	Kgr.	Kgr.	Kgr.
In cane stems ..	60,000	17,874	18·000	38·640	18·360	0·240
In leaves	30,000	8,054	36·900	33·000	33·300	39·800
Total	90,000	25,928	54·900	71·640	51·660	40·040

	CaO.	MgO.	K_2O.	NaO.	Fe_2O_3.	SiO_3.
	Kgr.	Kgr.	Kgr.	Kgr.	Kgr.	Kgr.
In cane stems ..	17·220	30·180	27·900	1·800	2·700	96·600
In leaves	29·700	21·300	145·800	0·600	4·200	151·410
Total	46 920	51·480	173·700	2·400	6·900	248·010

Total amount of mineral matter absorbed in one season :—

	Kgr.
In cane stems..	251·64
In leaves	496·01
Total	747·65

A consideration of these figures shows clearly enough that besides the necessary factors of careful selection and arrangement of soil, proper manuring must not be neglected; if the manuring is to be profitably carried out, then, above all things, the system of farming out for single cultures on the part of the large landowners must be given up. This method of letting the poor man work for himself is

convenient for the owner, who in consequence does not need to bother about the crop, but confines his attention to collecting his rents. As a result, one sees the disappearance of good cultures whose fruitfulness cannot be considered a real factor for very long; hence the larger tenants give up their leases as they perceive nothing more is to be gained from a particular soil, and the small fellahs, in the event of their getting into arrears with rent owing to bad harvests, are unmercifully, if legally, dealt with, and have to mortgage their own small possessions as a guarantee for the rent.

A widespread knowledge of manuring and its results being therefore of great importance for the whole Egytian husbandry, it may be asked what manures are the most suitable in Egypt for yielding a large crop of cane rich in sucrose, and at the same time for keeping the ground in a state of fertility. In the first place the Egyptian planter should provide for a good and ample "compost" manure. A high standard and well-conditioned stock of cattle contribute largely to that end. The cane leaves and other stubble from the fields should be employed as straw and stocked for that purpose. It can also be arranged to secure all the residue of defecation, washing waters, bagasse ash, &c., from the factory. If all these are combined, then a good beginning will have been made. The action of the stable dung depends on the degree of decomposition. It should not be used in the field until at least a year old. The writer has obtained very good results by spreading bone dust in the stalls, or mixing it in the manure heaps. In any case, a large proportion of the phosphoric acid contained in the bone dust went into the "compost" manure in a soluble form, and thereupon combined with the nitrogen.

Furthermore, the green manuring is of great value to the Egyptian soil, and its application is greatly to be recommended on account of its physical and chemical regeneration of the ground. In the alluvial soils of Java remarkable results have already thereby been obtained. As green manuring plants, we can include earth nuts, soja beans, lupines, indigo, and the different kinds of clover. They are sown at the same time as the cane cuttings are planted, at the side of the plant rows and somewhat higher, and some six or eight weeks after coming up are turned over into the soil.

Ruin and rubbish manure may be employed by the cane planter, if he believes them to be suited to his particular locality. In most cases little will come out of it owing to the high cost of transporting the requisite large amount, and owing to the uncertainty of its containing the small and haphazard amount of nutriment. Dove guano is to be recommended, yet owing similarly to its high price is almost prohibitive. The last two manuring mediums are mostly found in insufficient quantities, and of inferior quality.

In order to satisfy the high conditions of nutriment demanded by so ambitious, rich, and rapid growing a plant as the sugar cane, one

must needs resort to artificial manures. No man dreams of carrying on the manufacture of sugar with century-old machines under present conditions of competition, and, similarly, it is a prime necessity for the planters to apply to the sugar cane the latest discoveries and methods of agricultural chemistry and technology. Agricultural experiment stations have for a long time past been working satisfactorily in Europe, America, and the East Indies; and Java, that standard country for raw cane sugar, has practised for over 15 years a scientific system of cane growing, as have in part also the West Indies. Yet in general the manuring of the sugar cane is still a little known and elucidated sphere of work.

The figures relating to the crops and the results of experimental work show that Egypt's celebrated fertility is largely a thing of the past, and yet through careful methods of agriculture and by proper application of suitable manures, the present deterioration of crop yields can be superseded by good and lasting results. The stated quantities of mineral matter are absorbed from the ground by the canes in the course of a year, and under the present conditions of agriculture are not returned to the soil. Even the leaves which were hitherto burnt in the fields now go to the factory to be used as fuel.

It only remains to consider the three chief plant nutriments, nitrogen, phosphoric acid, and potash, and possibly also lime. The remaining equally needful substances on which the success of the plant depends are generally present in the ground, and in sufficient quantities, and need not therefore be taken into account. The necessary carbonic acid is obtainable in inexhaustible quantities from the air. Moisture, air and oxygen are supplied to the soil by proper tillage. The percentage of lime present in Egyptian soils is mostly a good one. Yet the writer found on different occasions in the course of extensive experiments that very good results follow from a manuring with lime. The latter is not to be considered directly a manure, but it acts as a medium, in that it oxidises non-reactionary substances so as to make them assimilable. In the case of so-called black earth and acid soils, a trial of lime manure is to be recommended.

(To be continued.)

From March 15th, the duty on sugar entering the Transvaal from England and her colonies was abolished, but on sugar from other countries it remained as before.

From Montserrat comes the news that some B 147 canes, which had been allowed to stand over from the last season, grew to an abnormal length. One of these, dressed ready for the mill, measured 18 feet and contained 56 joints, the longest of the latter being 7 inches between nodes.

THE CO-EFFICIENT OF DIFFUSION OF MACERATION WATER.

By E. E. Hartmann.

In No. 49 of the *International Sugar Journal*, Mr. Noel Deerr suggests a number of formulæ for the calculation of a co-efficient indicating the degree of diffusion of the maceration water with the juice in the bagasse. If the relation between the last mill juice and residual juice is used, Prinsen Geerligs' formula should be employed, for the water necessary to dilute a certain quantity of juice from 12 to 9 is the same as that required to dilute it from 4 to 3 per cent. This formula gives the same result in both cases, while according to Mr. Deerr's modification we would find $\frac{15-12}{15-9} = \cdot 50$, and $\frac{15-4}{15-3} = \cdot 92$. The other two formulæ are based on the assumption that the juice in the cane is homogeneous. If we bear in mind that when the first crushing juice (generally called normal juice) contains 17% of sucrose, the residual juice in the bagasse will (without maceration) contain from $14\frac{1}{2}$ to $15\frac{1}{2}$% sucrose, it is evident, that any calculations based on the assumption that the residual juice in the bagasse and the "normal juice" are of similar composition, must lead to gross errors.

In a paper published in the August number, 1897, of the *Hawaiian Planters' Monthly*, the object of which was to demonstrate the advantage of using the juice from the last mill for maceration, I proposed and used a co-efficient, which indicates the relation between the water actually used for maceration and the amount which would be required to accomplish the same result with complete diffusion.

Given sucrose and fibre in the bagasse from the second mill and that from the third mill and the quantity of maceration water, we have all the data necessary to find the quantity of water required to dilute the juice in Bagasse II. to the strength of Bagasse III., as it is evident that the percentage of sucrose in the juice in Bagasse III. is the same as that of the sucrose in the mixture of the juice and this quantity of water (the "diffusion water") in Bagasse II. after maceration:—

$$\frac{\text{Sucr. \% Bag. III.}}{\text{Juice \% Bag. III.}} = \frac{\text{lbs. Sucr. \% Bag. II.}}{\text{lbs. Juice in Bag. II.} - \text{lbs. Diff. Water.}}$$

Diffusion Water =

$$\frac{(\text{lbs. Sucr. in Bag. II.} \times \text{Juice \% Bag. III.}) - (\text{Sucr. \% Bag. III.} \times \text{lbs. Juice in Bag. III.})}{\text{Sucr. \% Bag. III.}}$$

$$\text{Co-efficient of Diffusion} = \frac{100 \times \text{Diffusion Water.}}{\text{lbs. Maceration Water.}}$$

Example.

These results have been obtained at a mill using the juice from the third mill for maceration on the first mill.

Cane: 10,000 lbs.

Bagasse II.: 2,465 lbs.; containing Sucrose, 6·09 % 150·1 lbs.
Juice, 53·34 % 1,315 „

Maceration Water: 1,540 lbs.

Bagasse III.: 2,167 lbs.; containing Sucrose, 3·40 %
Juice, 46·93 %

$$\text{Diffusion Water} = \frac{(150{\cdot}1 \times 46{\cdot}93) - (3{\cdot}40 \times 1{,}315)}{3{\cdot}40} = 762.$$

$$\text{Co-efficient of Diffusion} = \frac{762}{1{,}540} = 49{\cdot}5$$

Bagasse I.: 3,325 lbs.; containing Sucrose, 9·68 % 321·8 lbs.
Juice, 65·41 % 2,175 „

$$\text{Diffusion Water} = \frac{(321{\cdot}8 \times 53{\cdot}34) - (6{\cdot}09 \times 2{,}175)}{6{\cdot}09} = 644.$$

$$\text{Co-efficient of Diffusion} = \frac{644}{1{,}540} = 41{\cdot}8$$

756 lbs. of water applied on Bagasse II., and in addition 644 lbs. of water applied on Bagasse I., would with complete diffusion have accomplished the same as the 1.540 lbs. of water actually used on Bagasse II. and carried back as third mill juice on to Bagasse I.

The total efficiency of the Maceration Water can therefore be expressed by

$$\frac{(762 + 644)\,100}{1{,}540} = 91{\cdot}3$$

SUGAR CANE EXPERIMENTS AT BRITISH GUIANA.

By Albert Howard.

(1.) *Report on the Agricultural work at the Botanic Gardens and the Government Laboratory for the years 1896-1902.* By Professor J. B. Harrison, M.A., C.M.G. Issued by the Government of British Guiana, pp. 136.

(2.) *Return of the results obtained in plantations during the crop of 1901-2 by the Sugar Experiments Committee of the British Guiana Board of Agriculture.* By Professor Harrison.—British Guiana *Official Gazette*, January 3rd, 1903.

(3.) *The results of seedling cane experiments for 1902.*—*Demerara Daily Chronicle*, Wednesday, January 28th, 1903.

The raising and testing of seedling varieties is a subject to which a considerable amount of attention has been paid in recent years, not only in the West Indies but also in other cane growing localities. From time to time, judging from the reports of the Annual

Conferences held at Barbados as well as from published official correspondence on the subject, the hope has been held out that new seedling canes will be produced that will not only yield 40 to 50 per cent. more sugar than the older varieties, but will also, if placed under suitable conditions, withstand to a considerable extent the attacks of disease. Unfortunately however for the West Indian sugar planters, these prognostications, which were based on seedling experiments carried out in very small plots in Barbados and which were made before the nature of the chief sugar cane diseases was understood, have not, up to the present, been fulfilled. Both the Barbados seedlings Nos. 147 and 208, which were regarded as showing great promise and which were recommended to the planters for trial on their estates, are prone to fungoid disease. Especially is this the case with rattoons of B147 in Barbados—a cane that was considered to be so valuable both as a sugar producer and on account of its supposed disease-resisting character. When planted on an estate scale however it was found that not only was its juice so impure as to render the manufacture of Muscovado sugar a matter of some difficulty but the rattoons in many cases were practically worthless. Further, the amount of actual sugar obtained in estate cultivation fell far short of that calculated from the tonnage of canes on the plots and the analysis of the juice of a small sample of the canes crushed in a laboratory mill.

A critical examination of the results of seedling cane experiments published by the Imperial Department of Agriculture for the West Indies discloses the fact, recognised by many of the planters, that the plots have been far too small in area. Moreover, the produce of the plots has not been manufactured into sugar. The fundamental weakness in the method on which these experiments are conducted, comes out in a striking manner when the results of the official experiments are applied in practice. The actual yields of sugar on the estate often fall far short of that calculated from the plot results and of the estate yields of older varieties like the White Transparent.

As pointed out so clearly by Professor Harrison at the Barbados Agricultural Conference of 1902, small plot experiments, although necessary evils in the preliminary stages of seedling cane production, are of no value whatever to the planter. Professor Harrison said:—"No trustworthy way has yet been found to get the returns of plot experiments to conform with the results of field cultivation. We have often had results from plots that were simply astonishing. On paper a cane might yield six tons to the acre, and yet we know well that tried on a larger scale the yield would only be one and a half tons. Apart from the tonnage of canes there are many points that can only be settled by experiments on a large scale. The defective milling qualities and the deficiency of megass of some varieties cannot be discovered on small plots. . . . For decision as to the economic value of a new variety of sugar cane it is essential that results be

recorded as obtained on canes grown on estates' scale and treated under factory conditions. We have in British Guiana, at the present time, 2,700 acres under strict chemical control, as perfect as exists in any part of the world. Mr. Scard has 1,500 acres in varieties, and at all the plantations experiments with seedling and other varieties are being carried on as a continuation of the experiments with varieties begun in small plots in the Botanic Gardens, and, after careful selection, gradually extended to larger areas. I hope within the next eighteen months to have the figures of the results so obtained."

The results of over 2,000 acres of these experimental canes are now before us and are of such importance that they are reproduced in full below. There can be no question that the methods pursued in British Guiana are a great advance on those followed in Barbados and other West Indian colonies. Moreover they are calculated to prevent disappointment such as that experienced by the Barbados planters when imperfectly tested varieties like B 147 have been recommended for trial on their estates.

It has been the practice in British Guiana hitherto to publish the result of the work at the Government Laboratory and Botanic Gardens on seedling and manurial experiments at intervals of about five years. Such a proceeding, besides preventing hasty experimentation by the planters, greatly limits the bulk of the report, as the figures relating to unsuitable canes can be omitted. It is to be regretted that in future years annual reports are to be issued, as in the case of Barbados and Antigua. One of the objects of the work conducted at the Botanic Gardens at British Guiana is to produce seedling canes for trial on the estates. It is these large area tests which really interest the practical man who has neither the time nor the means to deal with voluminous details relating to preliminary tests. The earlier figures only interest the experimenter and it seems difficult to understand why the labour of compiling annual reports should be added to the work of carrying out the experiments themselves. The only annual reports that should be issued to the planters are those relating to the tests, on an estate scale, like that dealing with the seedling results of the 1901-2 crop. This document extends to less than three pages of print, nevertheless it must be admitted that it is the most valuable contribution to the West Indian sugar cane industry that has yet been issued.

It would seem that annual reports are necessary in view of the yearly Imperial grant-in-aid of £550 towards the cost of the experiments which is voted through the Imperial Department of Agriculture. This roundabout way of assisting the British Guiana work does not seem to have been a happy one. The relations between Professor Harrison and the Agricultural Department are referred to in the present report as follows:—

"From the establishment of the Imperial Department, money was voted by the Imperial Parliament to assist in our experiments. A

protracted correspondence took place with the Imperial Commissioner of Agriculture with the result that nothing was settled during the financial year of 1898-1899, and the grant-in-aid of that year lapsed into the Imperial Treasury. The correspondence continued during the earlier months of the financial year 1899-1900, and at times it appeared almost an hopeless task to arrive at a basis satisfactory to all parties upon which the experiments should be carried on. The original scheme drafted here was finally approved by the Secretary of State. . . . .

In working in co-operation with the Commissioner of Agriculture, it was soon found that difficulties and delays arose in connection with the expenditure of the moneys voted to the Colony as an Imperial grant-in-aid. After several modifications had been suggested, the Secretary of State solved the problem by relieving the Imperial Commissioner of any responsibility for the local experiments, and placing the control of the responsibility for the expenditure of the grant upon the officers in charge of the experiments. This arrangement continues up to the present, and has worked smoothly and apparently satisfactorily."

Apart from the difficulties of an official character under which the experiments have been conducted, serious interruptions to the growth of the experimental canes during 1898, 1899, and 1900, were caused by long-continued drought. In 1897, the trial canes were raided by thieves, who not only removed the larger ones but set fire to the rest, thus "in one day effectually destroying the work of months and doing considerable injury to the experiments."

The meteorological conditions and their effect on the growth of the canes are given at some length in the detailed experimental report, and the general conclusion is drawn that the crops of the Colony are mainly dependent on the amount of rain which falls between December 1st, in one year, and October 1st, in the succeeding year. The occurrence of heavy and well distributed rainfalls in the months of May and June or June and July is also of the first importance.

Old Varieties of Cane.

The results of the experiments with the older varieties of cane are of great interest and bring out the danger of relying on the produce of even four or five crops in ascertaining the value of a cane. Thus the Kara-ka-rawa cane, a practically valueless variety, gave very heavy crops from 1897 to 1901 while from 1886 to 1895 its yield was 54 per cent. less than that of the White Transparent.

Professor Harrison concludes that "the series of experiments with long known varieties of canes carried on continuously from 1886 to 1901 shows conclusively that prior to the commencement of the work with varieties raised from seed,—no varieties were obtained which under the test of a long series of successive crops have given more

favourable results than the standard West Indian varieties,—the Bourbon and the White Transparent."

The only canes of the older varieties which are now grown on the large scale in the Colony are the White Transparent and the Purple Transparent—1,900 acres of the former and 40 of the latter being now under cultivation.

Canes raised from Seed.

No difficulty is experienced in raising canes in practically unlimited numbers from seed in British Guiana, and many thousands are germinated each year. 313,500 seedlings were raised from 1896 to 1901 from which 19,000 were selected and planted out in the fields. Six old varieties and 56 selected seedlings furnished the seeds. The variation in the fertility of the arrows is very great—from one fertile seed to over 400 to an arrow. The production of fertile seeds seems to depend largely on the weather. Thus in the case of the Bourbon, fertile seeds seem to be only produced in quantity when the canes have been retarded in growth during the earlier stages and have arrowed while actively growing in October and November.

Since 1901, seedlings have only been raised from canes possessing properties of value which might be transmitted to or accentuated in their offspring. In many cases the arrows planted proved to be of great fertility, the seed boxes in many instances closely resembling lawns of fine grasses, the young canes growing so thickly as to mutually destroy themselves by hundreds and thousands. Experiments are also being made with a view of repeating the Java experiments on the cross-fertilisation of the standard varieties with other canes.

In considering the results given by the various seedlings on small plots, stress is laid on the fact that they are only of value in comparing the relative yields, under specific conditions, and for indicating their possible relative capabilities. They are of no value to the planters themselves.

The next stage in the history of promising seedlings is the trial on large plots, which enables their characters to be more fully studied, and provides a stock of plant-material for the crucial test—"*their yield when grown under estate conditions and over areas sufficiently large to enable judgment to be formed of their value, not only by their tonnage yield of canes but by the saccharine strength and freedom from deleterious impurities of their juice, and by the fuel value of the megass.*"

The importance of seedlings in "Bourbon-sick" soil is clearly indicated by Professor Harrison who sums up the results on this point as follows:—

"These results show that the new seedling varieties experimented with have on the Bourbon-exhausted soil of the manurial experiment field given returns of canes far in excess of those of the Bourbon, both when not manured

and when manured with nitrogen in different proportions. The new varieties also respond to a marked degree to nitrogen manurings.

"From the results of all our experiments it is clear that several new varieties of canes give yields far in excess of those of the Bourbon on soils on which the Bourbon has ceased or is ceasing to return profitable yields; this result has been very fully corroborated by the experiments conducted on many of the sugar estates of the Colony. It marks an advance of high importance, but the still more important, the crucial question:—will any of the new varieties give yields in excess of those of the Bourbon on soils where that cane flourishes, and if excess yields are obtained will they be profitable from the manufacturing point of view,—still remains unanswered."

The general deductions with regard to seedling canes are given as follows:—

"1. It is not possible to form an opinion as to the probable richness of the seedling progeny from the richness of the parent cane. This is applicable not only to the actual seedling but to canes propagated from it by cuttings.

"2. In the majority of cases the saccharine richness of the parent variety appears not to be transmitted to either the actual seedlings or to canes propagated from them by cuttings. But in the cases of a few varieties there has been found a tendency for the seedlings to approximate to the sugar contents of the parent kind.

"3. Similar conclusions hold good with regard to the percentage of non-sugars ('gums') present in the juice. The glucose-contents, and therefore the glucose-ratio and in part the quotient of purity are governed by the relative degree of maturity of the canes examined and analysed.

"4. Except in some of the more inferior kinds, among both the old varieties and seedling varieties, the size of the individual cane from which the seed is taken apparently in no way affects the size of its offspring, but there is no doubt, as has been repeatedly shown during the experiments, that the average size of the parent variety, with occasionally conspicuous exceptions, closely governs the average size of its offspring.

"5. Experience has not altogether confirmed the earlier experience with canes obtained from the seeds of seedling canes. Although the majority of the seedlings obtained from the seed of the seedling varieties show deterioration, some have been obtained of considerable promise.

"6. The fertility of seeds obtained from seedlings is far greater than it is in those obtained from the majority of kinds of the older canes.

"7. While the seedlings of the older varieties with but few exceptions show marked tendency to variation the seeds obtained from seedling varieties do not possess this property to anything like the same extent, and in many of them the offspring appears to come fairly true to parentage; this is especially the case among those we have studied with No. 95 and No. 74.

"8. The range of variation among the seedlings is far greater in those obtained from parents which are striped than amongst those derived from self-coloured canes, and this is so with regard to colour, size, and sugar contents."

The following seedlings only are recommended as being worthy of careful experimental cultivation in the Colony. Nos. 74, 109, 115,

116, 117, 125, 130, 132, 135, 145, 147 B., 625, 754, 1,087, 1,438, 1,640, 1,880, 1,895, 1,896, 2,028, 2,196, 2,468.

Besides the raising and testing of large numbers of seedling canes a very considerable amount of attention has been paid to the manurial requirements of the Bourbon and of the seedlings, and to the economics of the question. The plots on which the manurial experiments are performed are $\frac{1}{25}$ of an acre in area and contain 192 stools of canes. They are isolated from one another either by wide intervals or by drains two or three feet deep, thus preventing errors due to the washing of soluble manures from one plot to another during heavy rains. In the Barbados experiments this important point seems to have escaped attention, a fact which renders their value to some extent uncertain. The final conclusions, as to the action of manures on the crops of cane grown on the heavy clay land at the Botanic Gardens from June, 1891, to May, 1902, are summed up as follows:—

"1. Nitrogen in the forms of sulphate of ammonia, nitrate of soda, raw guano, and dried blood exerted a favourable influence upon the yield of the sugar canes, and is without doubt the manurial constituent, the supply of which mainly governs the yield of the plant.

"2. When supplied in quantities capable of supplying not more than 40 lbs. of nitrogen per acre there was practically no difference in the effects of sulphate of ammonia and of nitrate of soda, but on the whole the former is, in my opinion, the preferable salt to apply. Dried blood and raw guano were inferior to each of these. In the earlier crops of the experiments the best results were obtained by a mixture of one-third nitrate of soda and two-thirds sulphate of ammonia, but during the latter years this mixture has not proved more efficacious than either sulphate of ammonia or nitrate of soda alone.

"3. Where applied in quantities supplying more than 40 lbs. of nitrogen per acre sulphate of ammonia is the best source of nitrogen for the sugar cane on the alluvial soils of British Guiana.

"4. The sugar cane made more effectual use of the nitrogen supplied by 200 lbs. per acre of sulphate of ammonia and by 250 lbs. of nitrate of soda than it did of that supplied in heavier dressings. On the whole dressings of from 2 to 3 cwts. of sulphate of ammonia per acre appear to be the most certainly profitable applications of nitrogen, although at favourable seasons the use of still higher proportions may prove successful.

"5. The application of superphosphate of lime to plant-canes gave increased yields when added to manurings of nitrogen and potash. But little, if any, advantage was gained by the use of phosphates with ratoon-crops, and I am of opinion that manurings with superphosphate of lime or with other manures containing phosphates should be restricted to plant-canes, the ratoons being manured with nitrogen only.

"6. Mineral phosphates to give increased yields must be applied to the soil in such heavy dressings as to render their use decidedly unprofitable.

"7. As far as the experiments indicate Thomas-phosphate-powder (slag-phosphate) is the preferable source of phosphates for application to plant-canes in lieu of superphosphate of lime.

"8. The addition of potash when applied either as sulphate of potash or as nitrate of soda has exerted little or no effect. The normal weathering of the constituents of the soil sets free for each crop potash in excess of the quantity necessary for the requirements of the plants. This holds good under the conditions existent here, where the greater proportion of the potash taken up by the plants is directly returned to the soil, but where practically the whole of the produce is removed from the land it is probable that partial potash-exhaustion may take place in the course of a few crops.

"9. The use of lime has resulted in largely increased yields. But whether or not its use will result in profitable increases depends on the price of sugar. Its action appears to have been principally mechanical in improving the texture of the land, and it is a question of much importance whether this effect could not be obtained at a lower cost, and hence more profitable by the use of light plows or other cultivators.

"10. The results confirm those of previous experiments that neither the addition of phosphoric acid, of potash, or of lime to the manures favourably affects the sugar contents of the juice of the canes. The effects of nitrogenous manurings appear to be to somewhat retard the maturation of the canes and thus the juice of canes manured with them is, as a rule, not so rich in saccharose as is that of canes grown without manure. But this effect is far more than offset by the larger yields of produce resulting from the application of nitrogenous manures and to the fact that the increases produced by the nitrogen are principally due to the development of the stalks in length and in bulk and not to abnormal increases in the amounts of tops and leaves or the production of new shoots to the stool. In this the effects of nitrogenous manures on the sugar cane are very similar to those on others of the Graminaceae."

(To be continued.)

THE SUGAR INDUSTRY IN QUEENSLAND.

By J. T. Critchell.

(Continued from page 123.)

By 1879 sugar growing had spread considerably, and cultivation was distributed amongst (roughly) three districts; Bundaberg, latitude 25 south; Mackay neighbourhood; and the rainy belt, from the Herbert River, latitude 19 south, to Port Douglas, 16 south. These points are the centres of the industry.

As to the progress of the sugar growing, I may tabulate the following figures:—

Year.	Mills.	Acres of cane crushed.	Sugar manufactured. Tons.	Molasses. Gallons.	Spirits. Gallons.
1871	55	3,078	3,762	219,694	112,979
1881	83	12,306	15,564	602,960	201,111
1891	68	36,821	51,219	....	192,051
1901-2	52	78,160	120,858	3,679,952	171,626

The best yield that has been chronicled was in 1898, when 163,734 tons of sugar were produced, 4,000,000 gallons of molasses, and 131,000 gallons of spirit.

A good rough division of the colony into sugar districts is as follows:—South of latitude 24 (1900, acres under cane, 44,396, tons sugar produced, 23,298); between latitude 20 and 24 (1900, acres under cane, 29,032, tons sugar produced, 20,671); and north of latitude 20 (1900, acres under cane, 35,107, tons sugar produced, 48,585). Following are 1901 statistics for the whole State:—

Crushed. Acres.		Average yield of sugar per acre. Tons.		Tons of cane per acre.		Cane to sugar. Tons.
78,160	..	1·55	..	15·10	..	9·76

Visits to Districts.

I spent some days last May in Mackay, and Mr. T. D. Chataway, Editor of the *Sugar Journal*, kindly showed me round, and gave me much useful information. All Queensland was then suffering from a fearful drought, even the rainy belt not getting its usual quantity of precipitation. Mackay had had 22 inches in the monsoonal months, instead of the usual 40 inches, and in consequence the growing cane had suffered considerably, a crop of 18,000 tons of sugar was expected against the average of 26,000; Mackay has gone to 33,000 tons. The ratoons were very backward owing to lack of rain at end of 1901. Mackay notes include the following. Average proportion of cane to sugar $8\frac{3}{4}$ tons. The grub pest, virulent in past years, had been got under by a sort of "beetle bee," families turned out and joined forces with the Kanakas in attack, 12 tons of beetles were caught and boiled. One season 30 tons of beetles were destroyed. A parasitic wasp also plays havoc with this grub, in the body of which it lays its eggs. Another moth borer gives some trouble; the remedy is to cut out affected parts and burn. The worst of all borers is that which hails from New Guinea; it came some years ago with specimens of wild cane, which has all been dug out and burned. All pests are now well in hand. Bourbon cane, being liable to rust, is not used. I visited several of the mills, notably Habana, the proprietor of which, Mr. E. M. Long, is one of the most experienced and up to date sugar men in Queensland. Mr. Long was the first man in Queensland to adopt the system of increasing farmers' areas and decreasing estate crops. Cane, excepting ratoons, was looking well everywhere. Coffee is being grown in the district. A good deal of controversy exists as to the policy with regard to the Lantana plant, which has covered the whole neighbourhood, and threatens to become a serious pest; it is a good fertiliser, and makes splendid hedges, but requires to be kept well in hand.

About 1875, during a particularly adverse season, a bad attack of rust ruined the crop, and caused the industry in Mackay to receive a decided check, and its backers thought that the climate of the colony was unsuited to growing cane. At that time the Bourbon variety was almost entirely grown in Queensland. Cultivation, no doubt, at that date was very imperfect. Mr. R. W. McCulloch, in the Queensland

Official Year Book, states that the cane varieties, "Rappoe" and "Rose Bamboo," small quantities of which were grown in the early days, successfully resisted the disease which decimated the "Bourbon" cane. Mackay continued to be the headquarters of the industry, and fortunes were made there during the good prices which prevailed along in the seventies. As sugar growing spread, the northern lands were brought under cane; these districts, having a rainfall of from sixty to two hundred inches a year, and possessing the true tropical moist heat, seem to be the ideal home of the cane in Queensland. However, a little sugar growing takes place right down to the New South Wales border.

I was at Geraldtown, on the Johnstone River, for a few days, the region of perpetual rain. Sugar and bananas are the produce of the district. Of the latter no less than 1,320,620 bunches were exported from the port in 1901, cased and loose; taking an average, I make it that this means no less than 236,764,000 single "fingers" sent away that year. The fruit is mostly grown by Chinamen, who make a good living after paying £1 per acre per annum for uncleared scrub lands. A tramway runs from the port to Goondi plantation, and is continued farther to open up the fruit growing district. This municipal tramway system is seen in connection with several of the sugar growing neighbourhoods of Queensland, the local authority raises the money by loan, and builds and manages the lines, which are very useful institutions, and which mostly pay well.

The Pioneer plantation on the delta of the Burdekin river is notable as the first and only sample of a system of cane growing by irrigation—since my visit to the colony, however, irrigation has been applied to the Bundaburg district, as indicated above. The plantation belongs to Messrs. Drysdale Brothers, Mr. Douglas Brown is the Manager, and Mr. John Drysdale was in residence during my visit. About 450 hands in all are employed; 200 Kanakas, 90 Japanese, 30 Chinese, and 120 whites, and there are subsidiary cane growers. In 1901-02 there were 1,100 acres under cane, and 34,000 tons were taken off; an average of 31 tons to the acre, the highest yield was 70 tons. The estate is well developed, with a tramway running through it (a little locomotive made by the Hunslet Company called the "Pioneer" has done splendid service), a 60 ton mill, a splendid residence for the manager, hospital, good houses for the coloured labourers, and 15 pumping plants. There were 3,000 tons of firewood stored at the mill when I paid my visit, this wood is collected in the off season, when the unopened bush is cleared for cane by the Japs, who work on task work, partly: only raw sugar is made, which is sold to the Company. Messrs. Drysdale have 47 farmers round them growing cane for their mill; the average area of the farms is 300 acres, 50 of which will perhaps be under cane, the market price of which is about 12s. These farmers are financed from the plantation,

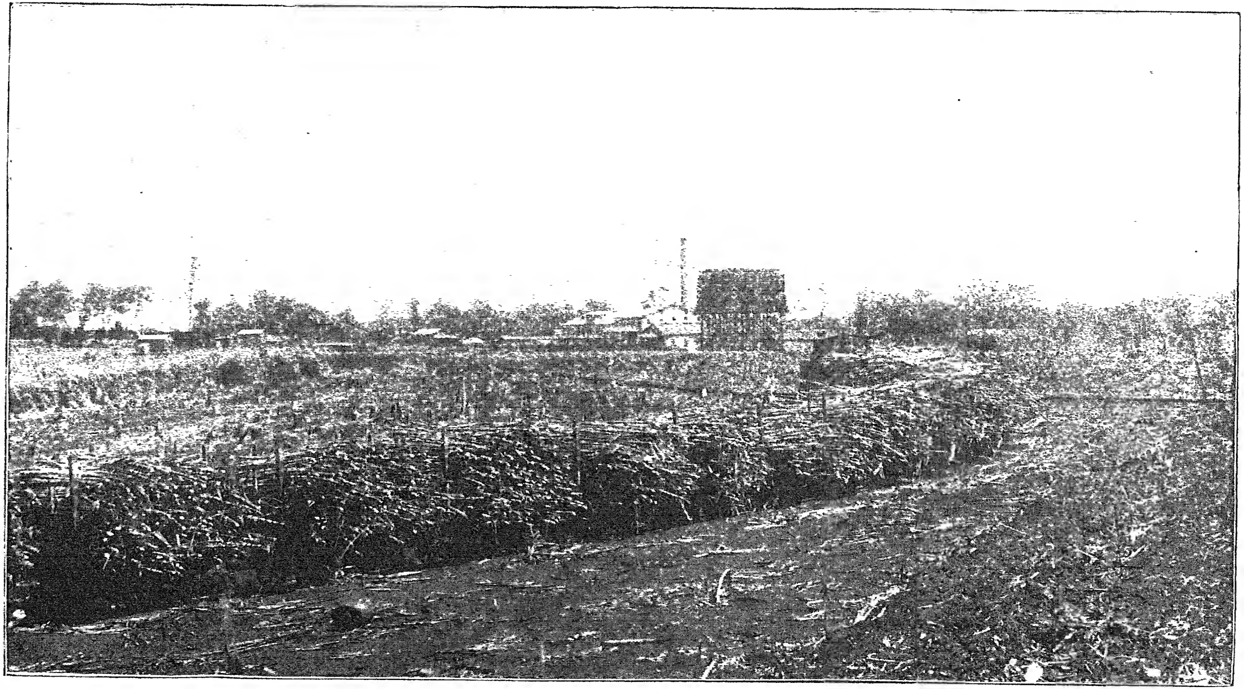
which supplies them with pumping plants and ploughs and teams; in good seasons this arrangement works well, and maize is grown on the space not occupied by cane. I noticed that on the Pioneer farms trashing was not practised, burning (carefully supervised by the plantation authorities) takes place before cutting.

In the whole of this district water can be easily drawn by penetrating the water bearing sand, saturated by the flow of the Burdekin river. The plantation water is drawn by powerful pumps from permanent lagoons, one draws 8,000 gallons a minute. The water is conducted by flumes to the cane fields, where it is run through the plants in channels. The farmers round, with their smaller requirements, use spear-point pipes for boring into the sandy soil, and generally strike water about 20 or 30 feet.

The climate of the Bundaberg and southern districts is not particularly well suited for cane planting, on account of the uncertainty of rain, and the occurrence of dangerous frosts. Light frosts are occasionally experienced at Mackay and the Herbert River, but these are not of sufficient importance to be injurious. In the ideal sugar growing land of the north, within the rainy belt, there are still to be obtained plenty of uncleared scrub lands well suited to cane cultivation. These lands have rich alluvial and volcanic soils, and are valued (10 miles from mills) up to £7 an acre.

Going southwards from Port Douglas—the farthest north—I give a record of the chief mills in the various sugar districts. At the Mossman river (Port Douglas) there is one central mill, the largest and one of the most successful in the State, which crushed in 1901, 56,000 tons of cane, and which put up a record in November, 1902, by producing a ton of sugar from 6·2 tons of cane. At Cairns, there are two mills, the Mulgrave Central, which handled 51,000 tons of cane in 1901, and Hambledon, belonging to the C.S.R. Co. On the Johnstone river, still south, there is a large mill belonging to the Company at Goondi, and one at Mourilyan, the property of the Union Bank of Australia. On the Herbert river, the southern border of the rainy belt, the Company have two mills, at Victoria, and at Macnade; Messrs. Wood Brothers and Boyd own the Ripple Creek mill. Going south again, we come to the Burdekin delta, where is the Pioneer estate of Messrs. Drysdale Brothers & Co., and two mills belonging to the Australian Estates Co., Seaforth and Kalamia—these two are managed by Messrs. Drysdale.

Approaching the important district of Mackay, there is the Prosperpine mill on the river of that name, a central mill establishment. At Mackay there are five central mills, Racecourse, North Eton, Marian, Pleystowe, and Plane Creek, and one mill, the property of the Company, Homebush; the Palms, (Australian Estates Co.), Habana, (Long and Robertson), Meadowlands, (W. H. Hyne's Executors), Palmyra, (H. Macready), and Farleigh, (till lately the property of the



ISIS CENTRAL SUGAR MILL, QUEENSLAND.

Cane Train.

late Sir John Lawes' Executors, this estate, mill, and 7,000 acres, cost from £70,000 to £80,000, and has been quite recently sold). Leaving Mackay, we next get to Bundaberg, where there is a refinery at Millaquin, owned by the Queensland National Bank, and managed by Mr. Eastick. This mill and refinery handles in all from 10/15,000 tons of sugar annually, and the refined sugar is sold in the open market. Fairymead belongs to the Messrs. A. H. and E. Young, and Bingera to Messrs. Gibson and Howes. This firm have recently spent £30,000 in irrigation plant, and have irrigated 1,000 acres of cane, which were expected to yield 35 tons last (1902) season. There are 12 other mills at Bundaberg, and six juice mills. South again to the districts called the Isis scrub; here there is the Isis central mill, which handled 30,000 tons of cane in 1901, the Childers factory belonging to the Company, and a small central mill in private hands. There are central and privately owned mills at Gin Gin, Moreton, Mount Bauple, Nerang river, &c., but those specified above are the principal, and give an idea of the distribution of the mills in Queensland.

The Company takes the whole output of Queensland cane, except that produced at Millaquin refinery, and Bingera, Fairymead, and Ripple Creek mills.

Out of the 108,535 acres under cane in 1901, Mackay claimed 24,000, the Rainy Belt 33,000, and Bundaberg and district 42,000. In that year 78,160 acres of cane were crushed, yielding 121,000 tons of sugar; there were 32,000 acres of stand-over or unproductive cane. The weight of cane was 1,180,000 tons.

Conclusion.

The Colonial Sugar Refining Company, referred to in this article as "the Company," finances the central mills in bad seasons, and handles practically the whole cane crop in Queensland, and, under the new system, will probably become the Sugar Trust of Australia—a beneficent rule. They fix the price at which they buy from growers and makers by taking the market prices for refined sugar at the following places:—Auckland, (New Zealand,) Adelaide, Melbourne, Sydney, and Brisbane—£8, say for 88%. If a rise occurs during the season at these points, the farmer gets the proportion (according to time of the rise), to the extent of 18s. in the pound. In the 1901-2 season, farmers got 39s. bonus. The proportions (of volume handled) figured out belonging to the cities named being respectively 16%, 11, 33, 33, and 7.

It will be seen that at present the sugar industry in Queensland is in an uncertain and complex condition. The grower of cane is protected by the Commonwealth government against over-sea competitors sending beet sugar to the extent of £10 per ton. He receives a bonus if he can get his crop cultivated by white labour from the same source, and the Company buys his product at a fair market rate, and divides any rise which thereafter may take place. The Company are distri-

buting during 1902-3 a special bonus, equal to 21s. 5¼d. per ton of sugar, towards carrying out the Commonwealth's intention of letting growers reap advantage from the difference between fiscal and Customs' duties, (excise £3 and duty £6). The Company are presumably retaining the large proportion of the difference to meet the fall in the price of sugar which has taken place.

We have yet to learn if exclusion of coloured labour is to be quite effectual; there are lots of Chinese and coolies in the northern territory, and unless government patrols are established along the rivers of northern Australia, there will be no means of keeping the Macassar boats from landing men, who can easily work into Queensland. If effectual, it may be taken for granted that sugar growing on a large scale will be severely injured in the north of the State of Queensland, in the south white labour—if available—may do.

Experience so far shows that an import duty of £10 a ton is not sufficient to check beet import into Australia, which will this year be an importer.

The terrible drought of 1902 was expected to cause a loss to Queensland sugar growers of about £10,000; in such a season the ideal position of growers is the rainy belt. Nothing but a good system of irrigation can ensure safety to planters in the dry districts.

The future of the industry in Queensland is limited only by the consumption in Australasia, which may be put at 200,000 tons. There is therefore any amount of room for expansion, supposing the labour question settles itself; in the future, if the industry develops, Queens-growers may make a profit say of £2 10s. a ton on 200,000 tons consumed in the Commonwealth and New Zealand, and will then be in a position to export say 50,000 tons surplus, on which they may be content with 10s. profit.

The January issue of the *Sugar Journal* gives the following figures to show the output of sugar in Queensland for the last three years. The figures for the season just ended are only approximate:—

	Year ending June 30, 1901.	Year ending June 30, 1902.	Apppox. Output for Season just ended.
	Tons.	Tons.	Tons.
Brisbane	2,869	2,962	1,000
Bundaberg and Gin Gin / Maryborough and Isis	20,429	36,205	17,500
Rockhampton	477	690	—
Mackay	20,194	24,093	16,750
Bowen	1,613	1,610	2,000
Burdekin	7,447	10,724	5,500
Herbert / Johnstone	21,230	28,692	23,500
Cairns and Port Douglas	18,295	18,882	18,500
	92,554	120,858	83,750

The decrease for last season was about 37,000 tons of sugar, or a loss of about £400,000. The record output of sugar for the past ten years was realised in 1898, when the yield was 163,734 tons of sugar.

There is much heated discussion in the Australian States just now concerning the not unimportant question as to who is to pay the rebate on white-grown sugar explained above. Is it to be a charge against the Commonwealth as a whole, or is it to come out of the excise duty collected? The Commonwealth Premier is believed to favour the payment of the rebate by Australia on a *per capita* basis, whilst other Ministers think that the two States concerned in the production of sugar, Queensland and New South Wales, should liquidate the amount. The fairest view of the matter, I think, is that the Commonwealth should defray the charge; having insisted upon a "White Australia," it should pay the piper. In New South Wales, where about 98 per cent. of cane growers have availed themselves of the rebate system, the question as to whether the burden of payment is to be borne by the State, or Australia as a whole, is a very important one indeed.

EXPERIMENTAL WORK IN HAWAII.

The Hawaiian Sugar Planters' Association have issued a pamphlet of about 100 pages describing the work of their experiment station and laboratories during the last few years. This included planting tests, investigations on the action of salt on the soil, and also on the cane. A number of voluminous tables are given, but to aid the reader a summary of the results is appended, and we reproduce it here:—

SUMMARY.

Planting Tests.—The average results of planting tests for two crops of cane gave the following order as regards yields:—

One eye per 12 inches.	One eye per 6 inches.
One continuous cane in row.	Two continuous canes in row.

One eye per 18 inches.

New Varieties.—Of the four new varieties of cane harvested in 1902, D. 74 gave the most satisfactory returns, yielding over 18 tons of sugar per acre. White Bamboo proved a very promising variety, yielding 14½ tons of sugar. These two canes were not only found to be good sugar producers, they were also economical in their requirements of plant food. Ottaheite and Salangore made but a poor showing.

Results with Ratoons of Varieties.—The highest yield of sugar with ratoons was 13½ tons obtained with Tibboo Mird; the lowest yield, 8 tons, with Fiji Purple. D. 117 and Fiji Purple gave larger yields with ratoons than with plant cane. The quantity of sugar produced by La. Purple and Striped Singapore was practically the same for ratoons as for plant cane. The highest average amount of sugar produced per acre for two crops (plant and ratoons) was 15

tons, yielded by Tibboo Mird. Fiji Purple gave the lowest average yield, the quantity being 6½ tons to the acre. The average purity of the juice in the ratoons of the varieties was 6·42 degrees higher than the average purity of the juice of the plant cane.

THE ACTION OF SALT ON THE SOIL.—Varying quantities of salt are contained in Hawaiian artesian waters. This ingredient of irrigation water renders available large amounts of the lime, magnesia, and potash in the soil. Where the water is saline, over-irrigations are necessary to keep the salt from reaching harmful accumulations in the soil, consequently enormous quantities of lime and magnesia, and a very large amount of potash must be washed out with the salt. Under such conditions the soil will eventually become depleted as regards these elements and become unproductive, unless they are replaced in the land. An application of ground coral or coral sand should occasionally be made to fields receiving water containing even moderate amounts of salt. The amounts of lime needed will vary with the saline strength of the irrigation water and with the lime content of the soil, If soils rather low in lime are receiving very brackish water the use of lime in large quantities in such form as ground coral or coral sand, is imperative to maintain the fertility of the land.

THE ACTION OF SALT ON THE CANE.—The quantity of salt that may be contained in irrigation water without producing material injury to the cane, varies to a large extent with the nature of the soil and the volume of irrigation used per acre. The quantities and proportions of the ingredients, other than common salt, contained in irrigation water also influence in large measure the action of such water on the growth of cane.

Cane planted in lysimeters grew apparently unchecked with its roots in contact with a soil water containing 195·75 grains of chlorine to the U. S. gallon. Cane absolutely refused to grow where the percentage of chlorine in the soil reached 0·198, the soil containing 28 per cent. of its weight of water.

Cane in lysimeters irrigated to excess with water containing 200 grains of salt to the gallon, made an apparently normal growth. In other tests with the same amount of salt in the water, but where excessive irrigations were not applied, the cane died.

In brackish irrigation water, the quantities of lime and magnesia are usually rather high, the latter element being in excess of the former. If it were not for the fact that the lime of the soil is considerably more soluble than the magnesia, where saline irrigation is used, the soil water would have an excess of magnesia over lime. The latter condition would be decidedly unfavourable to the growth of cane. As the lime is washed from the soil in greater quantities than the magnesia, it is necessary to apply the former element to the land to prevent the soil water from ultimately containing more magnesia than lime.

KESSLER'S CONTINUOUS DIFFUSION PROCESS AS COMPARED WITH THE WORK IN THE BATTERY.

By Walter Tiemann.

In No. 45, Vol. IV., of the *International Sugar Journal*, Mr. H. Maerker described the new Kessler process, after the description given of the same in the patent specification and explained in the first place why the diffusion process in the manufacture of cane sugar has, up to the present, been unsuccessful.

This study is very interesting, but still the subject has not been treated with that thoroughness which the great importance of it demands, as the present defective method of extracting the juice from the cane is a question of vital importance, a question of life and death, so to say, for the cane industry.

The diffusion process must and will be the process of the future also for cane, the same as extraction is exclusively used for beet; it must however :—

1. Not only extract the highest percentage of sugar but also
2. A juice of the highest possible concentration,
3. A juice of the highest possible purity,
4. All with little expense and less attendance and last but not least,
5. The exhausted cane should be as good a fuel as the one coming from the mills at present, so that with a good plant the manufacture can be carried on without coal or wood.

The exhausted slices of the old battery were freed of the water, as far as possible, by means of pressure, but this operation can only be carried out very imperfectly with the slices. As the slices are cut crosswise to the longitudinal fibre of the cane they are perfectly ground to small particles and powder by the pressure without being freed of the water. With their 65% and more of water these exhausted slices cannot be used as fuel; the drying of the same by mechanical means, or in the sun, is troublesome and expensive; and finally a great deal of the powdered material or dust is carried off from the furnaces into the flues by the draught of the chimney.

These drawbacks are removed by the Kessler process as the cane is not diffused in slices but prepared by crushing-machines in the usual manner. This method of reducing to pieces is of course unsuitable for an extraction in the old diffusion-battery, but just the right thing for the Kessler apparatus, the contents of the greater part of the ruptured cells are readily and easily obtained by simple extraction, so that the actual diffusion process proper extends only to the small mass of unbroken cells; this also explains why only a diffusion of from 20-40 minutes is required.

The distribution of the crushed cane, which is compressed in uniform layers, is further more advantageous for a uniform circulation

of the diffusion liquid than are the slices in the battery, as the latter do not form uniformly narrow channels and interspaces.

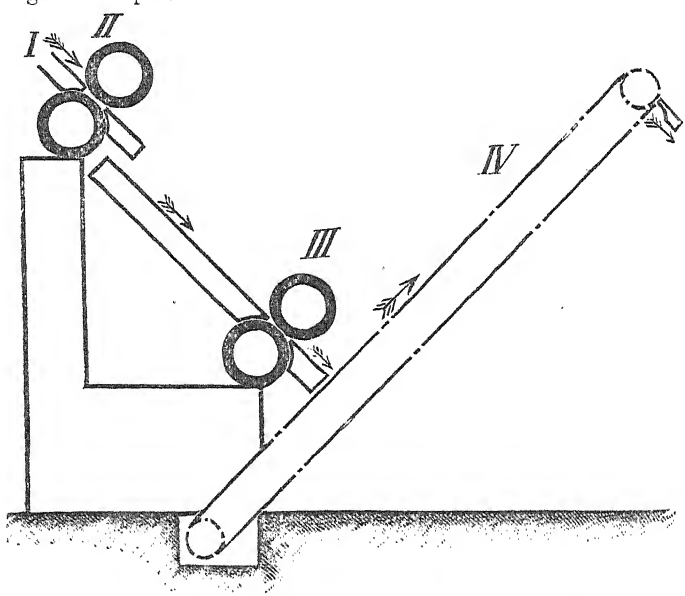
By crushing the cane the following great advantages are obtained :—

1. The treated material, after the diffusion, can be dried more perfectly by the mill, being pressed at 60-70°C immediately after leaving the diffusion-apparatus; it therefore forms a more combustible fuel than the bagasse imbibed, and a much better combustible than sliced cane.

2. The machines for crushing, or cane-breakers, are cheaper and not so delicate as slicing-machines, also less expensive in their working; some of them are of a perfect construction.

3. The amount of the cane mass to be treated by the diffusion is proportionately very reduced, as already 40% of the juice has been extracted in the crushing; the sliced canes in the old battery require a large plant, whereas with this invention only a comparatively small apparatus is required.

We will now briefly state, on the basis of the drawing, the principal stages of the process.



From the conveyor I. the cane is carried to the first crusher, II. from which in passes in a changed position to the second crusher, III. in order to be still further reduced to pieces. From here the now sufficiently crushed cane is carried by the conveyor IV. to the diffusion apparatus, in order to be subjected to a systematic diffusion process beginning in vacuo in a continuously working apparatus A,

D, D[1], D[2], D[3]. The crushed cane, which is introduced into the apparatus by A[1], is distributed in uniformly superposed layers, with small spaces for effecting a rational diffusion. This compact mass is mechanically driven forward by a strong conveyor (B, C,) in an opposite direction to the diffusion liquid, which penetrates the mass, and the latter is finally taken hold of by the pressing device (E), which easily compresses it and discharges it at F.

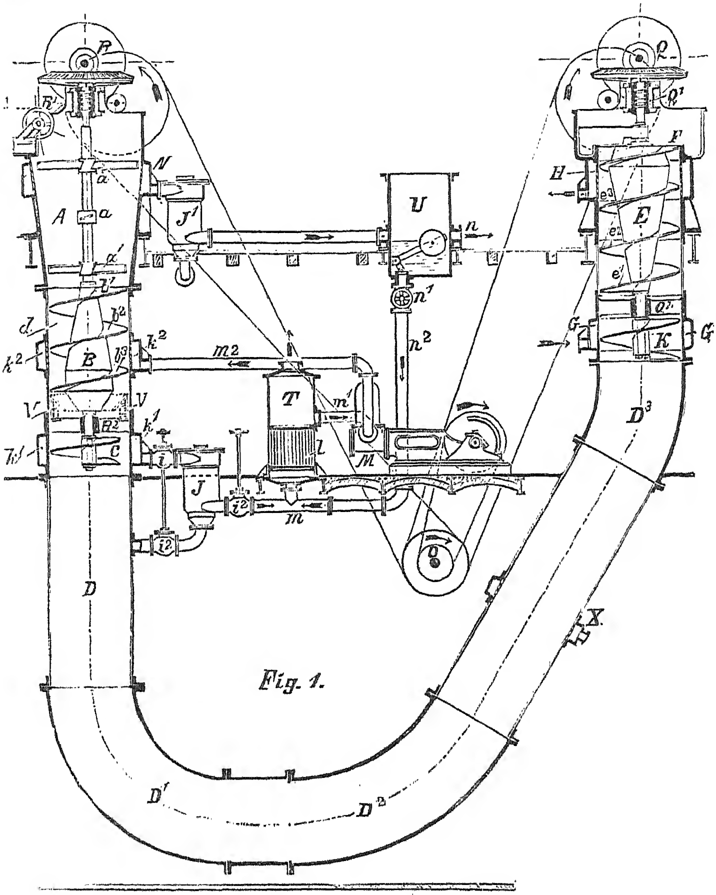


Fig. 1.

Water at the required temperature and pressure enters in a continuous current at G into a double cylinder, the inner wall of which is perforated. The diffusion process takes place throughout the whole column of crushed cane and the juice is then discharged at N.

Each end of the apparatus is provided with a pressing device of special construction, B at the inlet which compresses the cane mass mashed with juice, and E at the outlet which compresses the crushed cane saturated with water. This special closing system enables the use of a vacuum at the beginning of the diffusion process while subjected to the pressure of the water.

The mashing and also the heating of the fresh cut cane are effected simultaneously by means of the juice heated in the calorisator 1. This juice being discharged at k^1, is sucked by the vacuum of the receptacle T while passing through D; then it is drawn by the circulating pump m to k^2, where it serves for mashing the fresh crushed cane, and gives off its heat to the same. Consequently, as the operation of the conveyor B is continuous, all cane mass is successively brought in contact with the warm mash-juice, which forms a very essential improvement.

J and J^1 are filters which separate the fine particles of cane from the juice.

U is a regulating and measuring vessel, which gives back one part of the juice to the circulation pump M, and leads off the other part measured to the defecation.

The double mantles at G, K^1, and K^2 are so arranged that the windings of the screw brush the inner walls, and thus prevent an obstruction of the sieve holes.

From the diffusion the extracted cane is fed to the mill V., which presses out the sweet water, and at 60-70° C., so that the bagasse oozes out exceedingly well dried, and forms a dryer fuel than the present mills with strong imbibition.

It may be found convenient, if there is already a crusher existing in connection with a mill, to let the cane pass consecutively through two crushers, through one crusher and the mill, and then into the diffusion apparatus, so that the latter will be inserted between the first and second mill. The first mill, and also the second mill, produce in this case a much greater quantity; a third mill is, of course, not required.

The sweet water from the mill is thoroughly freed, by a new and exceedingly effective apparatus VI., of the finest particles of cane, and is at once continuously heated with the addition of a little lime and carried through the pump VII., partly for the purpose of diluting the defecation scums for a more effective filtration in the filter presses; a part of it is carried direct into the diffusion apparatus, for instance at X., where also sweet water from the filter presses enters.

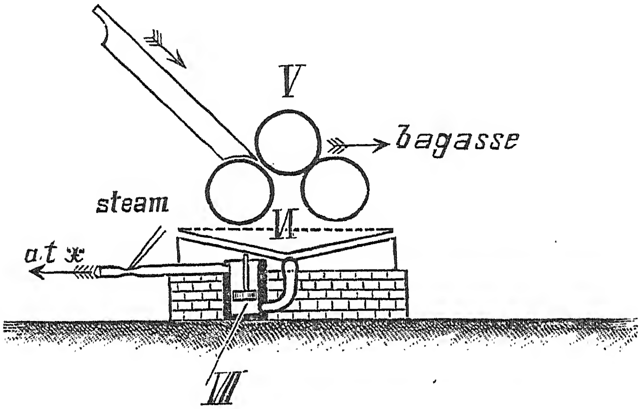
With these precautionary measures all the sweet waters and washing waters of the factory can, owing to the quick and continuous working of the Kessler apparatus be used very advantageously for diffusion and with the most simple arrangement, so that only solutions of sugar in the natural concentration of cane juice require to be

evaporated, as also the Kessler process gives the cane juice almost undiluted.

Of course all losses of sugar are also avoided in this way.

The cost of evaporating the diluted juices is very high, in many cases as high as the price of the additional fuel, wood or coal, which is not required with the Kessler process, so that the output of the factory rises 20%.

In order to compare the different diffusion processes it is necessary and interesting to describe at the same time more in detail all the principles and proceedings of the diffusion, as far as this has not been done already in the above mentioned article by Mr. H. Maerker.



In the first place in should be borne in mind

1. *That only about 60% of weight and volume of the cane, as against sliced cane, require to be diffused*, as 40% of juice has been extracted by crushing.

2. That that 60% of crushed cane occupies in the Kessler apparatus only 45-50% of space, as against 100% of sliced cane.

3. That also this 60% requires only $\frac{1}{4}$-$\frac{1}{3}$ of the ordinary diffusion time; the space required in the apparatus is therefore much smaller, and the cost proportionately lower.

The column of crushed cane in Kessler's apparatus is in fact less than the sum of the heights in a battery having five diffusers.

It is however at all events well to take into consideration that the mass of crushed cane in Kessler's apparatus is very considerably more compact than in the old battery, but this does not imply a pressure in the real sense of the word.

One hl. space in the battery contains 43 kilos. of material and 70 liters of water, while in Kessler's apparatus, where each space is used to advantage, we have 70 kilos. of material and 35 liters of water in the same volume.

There are absolutely no waste spaces in Kessler's apparatus.

The mass, composed of uniformly superposed layers, contains only small and completely uniform spaces, through which the liquid can freely circulate. No passages are formed.

There are also no sieve bottoms, on which the mass lies, as with the diffusing receptacles in the battery.

In the battery the holes of the strainers are partly stopped up by the slices, which repeatedly takes place in every diffuser, and are adverse to the circulation of the liquid, and even a greater resistance than that of the slices themselves.

The single strainer in Kessler's apparatus, which serves for the discharge of the juice (k^1), does not show this drawback, because the material constantly moves along this surface, so that the spaces in the mass and the holes of the strainer always coincide with each other.

In case of emergency, even the juice can be forced back again into the apparatus, whereby the holes will be immediately free agam.

A further advantageous feature for good circulation is that during the first half of the process, generating gases rise upwards, and thereby assist the forward motion of the liquid, instead of preventing the waste, as in the battery.

The former mashing method, in which a part of the material was always subjected to an increased temperature, changed the structure of the slices, thus affecting the circulation. This drawback is obviated by Kessler's mechanical mashing process.

The production of a vacuum at the beginning of the diffusion process and the continuous working of the same are very effective for a rational extraction, while the presence of air and gases in and between the cells can retard the osmotic action for a comparatively long time.

An adequate vacuum can be produced in the calorisator *l* and in the recipient T, in order that the juice may boil and the foam (air containing juice) burst. The air escapes under the action of the pump; consequently the mashing does not bring air immediately into circulation (as against the drawback of Naudet's process).

The whole mass of slices is subjected to a higher temperature, within the limits acknowledged as practicable.

The fresh cane mass is brought to the increased temperature according to the old system of Jelinek, but in the present case by means of automatic mashing, and the water enters properly heated.

We might also refer to the fact that the mass of crushed cane is moved forward in an opposite direction to the diffusing liquid.

The combination of these circumstances and their combined effect favourably influence the diffusion process to such an extent, that its duration is reduced more than one-half without effecting the other requirements, *i.e.*, a good extraction. The capacity per hl. volume is thus considerably increased.

The improved process meets all requirements necessary for the extraction of juice as concentrated as possible.

The uniformity of the mass consisting of uniformly superposed layers—without waste spaces and without passages—ensures a regular circulation of the diffusing liquid.

In one word: the diffusion according to Kessler's process is effected in a real systematic manner.

The filling of Kessler's apparatus is effected in quite a different manner to the battery-diffusers; according to the latter, the slices are thrown or dropped in, whereby a conical-shaped mass is necessarily formed, whose middle point is always more compact than the outer edges, and the liquid of course preferably takes that course, where it meets with the smallest resistance.

The mashing from below does not have much effect on this drawback: the circulation remains irregular, hence there is a decrease of the density of the juice, an irregular extraction, &c.

The best distribution in more compact layers (Kessler's system) requires a more favourable proportion between the slices and the liquid, *i.e.*, the water which is adapted for extraction.

Hence, a corresponding acceleration of the circulation results therefrom, or, in other words, *the diffusing quantity of cane mass is much larger than that of the water which passes therethrough.*

In this manner the desired degree of sugar extraction can be much easier attained.

Since the quantity of water flowing through the slices during the diffusion process is less, it is obvious that the juice extracted must be more concentrated.

The advantages just mentioned go hand in hand with the extraction of a juice as pure as possible.

The quantitative proportion of the liquid and the cane mass is in fact an important factor of this result,—the less water, the less dissolved non-saccharine substances. Further, the duration of the diffusion—with suitable temperature—and also the contact of the liquid with the slightly soluble substances, is considerably shortened and consequently there are far fewer foreign substances in the juice. The detrimental action of the air and gases is obviated through their absence.

By the mechanical mashing and heating of the fresh slices the superheating and decomposition of the same are avoided, while in the battery, where the unmoved layer always receives very hot juice, the case is very different. Already in the year 1894, Melchior called attention to this drawback, whose detrimental influence also affects the purity of the juice. In Kessler's process, however, the crushed cane mass does not undergo any change whatever.

In the battery the extraction of the last particles of sugar requires much space and time, and especially with medium and low tempera-

tures, whose bad consequences are obvious. Many slightly soluble substances, which were not dissolved during the preceding stage of extraction, unavoidably pass into the juice.

In the improved process the extraction need not be carried on so far, for it should not be forgotten that in consequence of the pressing device E., a portion of the sugar contained in the extracted slices returns to the diffusing water.

Consequently the cane mass contains much less liquid when driven out of Kessler's apparatus than when discharged from the battery.

All these factors are instrumental in attaining with the new system the extraction of a purer juice than with the old process.

(To be continued.)

CONSUMPTION OF SUGAR PER HEAD IN EUROPE AND NORTH AMERICA,

For the Years 1900-1901 and 1901-1902.

	1901-1902.			1900-1901.	
	Kg.	lbs.		Kg.	lbs.
Great Britain	44·47	97·83	...	44·52	97·94
Switzerland	27·75	61·05	....	24·29	53·44
Denmark	24·52	53·94	....	23·40	51·48
Holland	21·21	46·66	....	20·12	44·26
Sweden and Norway ..	20·84	46·00	....	17·89	39·36
France	15·81	34·78	....	16·64	36·60
Germany	13·82	30·40	....	13·88	30·53
Belgium..	11·44	25·17	....	10·73	23·60
Austria-Hungary	8·37	18·41	....	8·11	17·84
Russia	7·76	17·07	....	6·53	14·36
Portugal and Madeira ..	6·41	14·10	....	6·42	14·12
Spain	4·48	9·85	....	4·55	10·01
Greece..	3·67	8·07	....	3·41	7·50
Turkey	3·66	8·05	....	3·66	8·05
Italy	3·27	7·19	....	2·80	6·16
Servia	3·13	6·88	...	3·12	6·86
Roumania	2·85	6·27	....	3 46	7·61
Bulgaria..	2·80	6·16	....	2·67	5·87
All Europe..	12·88	28·33	....	12·57	27·65
North America	32·02	70·44	....	30·29	66·64
Mean	15·86	34·89	....	15·28	33·61

From Argentina comes an order for the necessary plant and machinery to turn out 250 tons of molascuit a week. At present this commodity commands a wholesale price of about £5 10s. per ton in London.

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. Thompson, C.E., F.C.S., M.I.M.E., Chartered Patent Agent, 6, Lord Street, Liverpool ; and 322, High Holborn, London.

ENGLISH.—Applications.

3373. A. Freitag, London. *An improved process of and apparatus for evaporating or condensing sugar juices, salt solutions, and the like.* 12th February, 1903.

3563. R. Barge and L. Givaudan, London. *An improvement in the manufacture of saccharine.* 14th February, 1903.

4858. C. Sudre, London. *Process of treatment of the residuary liquors of sugar factories.* (Date applied for under Patents Act, 1901, 3rd June, 1902, being date of application in France.) Complete specification, 2nd March, 1903.

5280. L. Naudet, London. *Process of and apparatus for the diffusion and extraction of saccharine juices.* 6th March, 1903.

Abridgments.

3295. J. J. E. Bekker, Utrecht, Holland, and R. Harvey, Glasgow. *Improvements in and relating to mills for grinding sugar cane, and like grinding purposes.* 10th February, 1902. This invention has reference to improvements in and relating to mills for grinding sugar cane, and like grinding purposes. According to these improvements, two rolls are placed one directly below the other, and a third roll is placed out from these at an angle preferably of about 65 degrees from the centre of top roll.

6065. S. A. Jackson, Heaton Chapel, Lancashire, and A. J. Pennington, Withington, Lancashire. *Improvements in the process of manufacturing or purifying saccharine.* 12th March, 1903. This invention relates to an improved process or methods of treating crude saccharine to separate the constituent part which has sweetening properties from that part which is inert or non-sweetening. It consists in treating the crude material in excess (preferably at a raised temperature) with such a quantity of acetone as is insufficient to dissolve all the ortho-acid in the mixture and any of the para-acid before a saturated solution of the ortho-acid is formed, and then crystallising out the ortho-acid or evaporating to dryness at one operation.

22537. C. B. Duryea, Iowa, United States of America. *Process of producing maltose syrups and sugars.* 16th October, 1902. This invention relates to a process of producing maltose syrups and sugars with the object in view of economising time, fuel and labour, and increasing the yield, thereby bringing the cost of the concentrated product down to a competitive basis of cost with glucose products.

It consists in providing a thin boiling or modified starch, having mixed therewith a very dilute acid, cooking the mixing, neutralising the acid, treating the mass with malt, and finally separating the maltose from the mass.

GERMAN.—ABRIDGMENTS.

135678. JOSEPH ROBIN-LANGLOIS, Paris. *An apparatus for boiling down, mashing, and centrifuging sugar products.* 3rd January, 1901. The apparatus consists of a number of sets or rows of vats, each of which consists of a mashing apparatus, a melting pan arranged above it, and a centrifugal erected beneath it. These sets or batteries are used systematically by sugar and the water serving for casing it, and the syrup formed from the sugar and water, being conveyed through the apparatus in opposite directions to one another, so that the sugar comes in contact with always purer and increasingly thinner liquid. The raw sugar is dissolved in the first melting pan of the second row in $\frac{1}{5}$th part of water of 100 to 110°, the syrup obtained is run into the mash pan below and allowed to gradually crystallise out by cooling, the green syrup is centrifugalled off in the centrifugal beneath the mashing apparatus, and the sugar is conveyed by a scoop mechanism into the melting pan of the third row, where the same processes are repeated, and so on up to the fourth row, from the centrifugal of which the sugar is obtained pure white. The most impure syrup is boiled down to exhaustion, mashed and centrifugalled in the boiling down apparatus of the first row, which corresponds to a melting pan. The drain is final molasses, the sugar as raw sugar is again dissolved with raw sugar in the second row, and so forth.

135679. RÖHRIG & KÖNIG, Magdeburg-Sudenburg. *A process and apparatus for producing a vigorous circulation in evaporating or boiling down apparatus.* 21st December, 1901. (Patent of addition to No. 126615, of 9th December, 1900.) The centre part of the heating arrangement (with vertical heating pipes) projects considerably above the other part, and is heated with steam of higher pressure. The sugar juice to be evaporated or boiled down consequently rises vigorously upwards in the central part of the heating apparatus, pours out of the upper openings over the outer part, and descends in the latter, returning from beneath into the central part, and thus having a constant vigorous circulation.

135680. L. PRANGEY and J. DE GROBERT, Paris. *Process and apparatus for evaporating and boiling down sugar juice and the like.* 29th January, 1902. The interior space of the evaporator or boiling down pan is divided into several chambers by partitions, which are combined into a single chamber in proportion to the increase in the quantity of juice produced by the running in of fresh juice in order to prevent too high a level, which would be deleterious, and this is done by adjusting or removing the partitions gradually or successively.

The apparatus may also for the same purpose be so arranged that from an inclined position it may be caused to assume a horizontal one, in order by the gradual inclination of the apparatus to expose to the increasing mass to be boiled gradually a larger evaporating surface without increasing the level of the liquid, or several superposed evaporating vessels may be placed in communication, having successively larger evaporating surfaces.

135681. A. Holland, Magdeburg-Sudenburg. *An arrangement in centrifugals for separating the drain inside the same.* 12th March, 1902. (Patent of addition to Patent No. 126673 of 20th March, 1901.) Whilst in the arrangements in centrifugals described in Patent No. 126673 the drain is separated in two qualities, by the present patented arrangement a separation into three or more qualities is possible. In order to attain this object the ring disc covering all the outer channels formed by annular projections on the collecting dish is provided with progressively displaced slots, arranged side by side and of equal length, of a width approximate to that of the outer channels, in such a way that between each series of slots a portion of the ring disc extends to the full width of the ring and the length of the slot, so that at each revolution of the annular cover provided with slots of the length of an annular disc slot, the drain may be conveyed to the desired channels to the extent of the length of one slot.

135682. Max Schosstag, Berlin. *A process of purifying bi-strontium saccharate.* 22nd September, 1901. The bi-strontium saccharate obtained by separation is first systematically cased in the ordinary manner with strontium hydrate solution, and then with already used non-sugar lyes of increasing purity. By this means a saccharate of pure white colour is obtained, and the sugar juices obtained therefrom show a considerable diminution in the amount of salts contained.

135880. Ferdinand Kessler, Rosario, Argentina. *Process for continuous diffusion or extraction of beet shreddings, bagasse, dye wood or tanning wood, and the like.* 9th November, 1900. The material to be treated such for instance as beetroot shreddings, bagasse, disintegrated dye wood, tanner's bark or wood, and the like, is moved mechanically against the extracting liquid, the diffusion process being thereby commenced under vacuum in the uniformly tight packed mass inside a diffuser not provided with forwarding and heating devices, and proceeding in further course under pressure. The concluding means employed, both where the liquid is under a diminished as well as an increased pressure in the extracting vat, is the action of a press on the material to be treated both on its entrance as well as on its discharge from the extracting apparatus. The latter may be formed of a U shaped bent pipe, or two pipes standing vertically one above the other, into which the material is introduced by a tapering conveyor

worm, and pushed forward whilst the extracted material is pressed and removed by a second similar worm. The material is also penetrated in the opposite direction by the extracting water, and thus a constant systematic extraction is obtained.

136670. Dr. ALEXANDER KOLLREPP, Berlin, and Dr. A. WOHL, Charlottenberg. *A process for electrolytic purification of saccharine solutions by the addition of easily attackable basic lead or zinc compounds.* 17th November, 1901. The acids set free in the electrolysis of sugar juice are separated out by means of suspended basic lead or zinc compounds, more particularly lead saccharate. For this positive electrodes may be employed, which are neither attacked nor rendered ineffective through firmly adherent deposits. The lead precipitates obtained as bi-product are converted, by means of saccharine solutions and alkali, into lead saccharate, which is again utilised.

137073. FRANZ MAY, Hatschein. Moravia. *A device for catching sand and stones in the washing of sugar beets.* (Patent of addition to Patent No. 94300, of the 23rd October, 1896). 12th March, 1902. In order to prevent the beets sinking to the bottom, in the device for catching sand and stones described in Patent No. 94300, the troughs traversed by the beets to be washed are provided with two parallel bottoms, the upper one of which is perforated and the under one provided with a nozzle, through which water, air or like gas is driven, which again drives upwards in the stone catcher any roots which are sinking, and causes them to float further on in the latter.

137189. HERMANN HILLEBRAND, Werdohl. *A front knife for double knife boxes in beetroot slicing machines.* 7th January, 1902. In order to protect the cutting edge of the rear knife against damage from foreign bodies, the ribs of the upper ribbed knife employed as a preliminary cutter are partly removed at the end of this knife, so that interstices are formed between the separate ribs, which are left untouched. The foreign bodies coming into these interstices then slip away under the edge of the rear knife or cutter without injuring the same.

137297. DR. HEINRICH WINTER, Charlottenburg. *A device for sharply separating discharges of different composition inside a centrifugal.* 15th February, 1902. The shary separation of the drain or discharge of different composition is operated inside the centrifugal by means of an inner casing introduced between the drum and the outer casing, said inner casing being composed of separate movable plates resembling Venetian blinds, which in each of their two principal positions are only used on one face for the discharge.

137330. ERNST ROBERT LOUIS BLUMER, of Zwickau, Saxony. *A process for making soluble starch by means of volatile organic acids.* 21st June, 1901. The starch is gradually heated for five to six hours to 115° with about 1% of a volatile organic acid, such for instance as

formic acid or acetic acid, in a vessel provided with double walls, stirring apparatus and distilling hood, and then by distillation the surplus acid is removed, which is condensed and employed for a fresh operation. At the end of the operation a sample of the starch must dissolve perfectly clearly in water at 60° to 70°, but yields a starch reaction with a solution of iodine.

137386. Fritz Scheibler, Aix-la-Chapelle. *A double chopping machine for making whole layers of rectangular sugar cubes corresponding to the sugar slabs.* 5th January, 1902. In order to be able to produce layers corresponding to the sugar slabs of rectangularly broken sugar cubes of suitable size without waste by means of a double chopping machine, the pairs of knives are arranged at right angles to one another, and are separately operated so that it is possible to adjust the knives to any desired size of cutting.

137555. C. W. Stöcker, Gräfrath, near Solingen. *A double knife box with rigidly attached seat for front and rear knives.* 29th March, 1902. The mounts for the front and rear knives respectively, are connected by revoluble bars in the end walls of the knife box, so that when these bars are turned, both knife mountings and the knives fixed thereon may be adjusted or displaced.

137570. August Neumann, Berlin. *Shreddings Press.* 22nd January, 1901. The space between the inner cylindrical casing of the press and the outer casing, widens constantly outwards from the upper edge to the under edge, so that larger discharging spaces are provided in the lower part of the press for the larger quantities of exhausted pulp and water.

Copies of all published specifications with their drawings in these lists can be obtained from W. P. Thompson & Co., 6, Lord Street, Liverpool, at One Shilling a copy for English or American Patents, and Two Shillings for German. In ordering please give number and date.

Mr. H. Maxwell-Lefroy, till lately on the staff of the Imperial Department of Agriculture for the West Indies, has been appointed Entomologist to the Government of India.

IMPORTS AND EXPORTS OF SUGAR (UNITED KINGDOM),

To end of February, 1902 and 1903.

IMPORTS.

Raw Sugars.	Quantities.		Values.	
	1902.	1903.	1902.	1903.
	Cwts.	Cwts.	£	£
Germany	2,107,415	551,609	775,452	209,735
Holland	129,790	63,052	43,892	23,738
Belgium	282,896	181,609	105,835	74,122
France	1,063,599	20,086	429,808	8,646
Austria-Hungary	43,032	717,208	15,090	300,071
Java	....	....	....	....
Philippine Islands	....	....	....	
Peru	32,800	31,271	11,683	11,354
Brazil	86,061	30,625	30,011	11,471
Argentine Republic	357,264	53,432	139,865	23,088
Mauritius	60,940	651	22,185	320
British East Indies	26,277	43,393	12,745	16,057
Br. W. Indies, Guiana, &c.	119,950	56,934	76,541	37,945
Other Countries	40,614	57,655	17,255	25,032
Total Raw Sugars	4,350,638	1,807,525	1,680,362	741,579
Refined Sugars.				
Germany	3,957,949	1,802,689	2,121,423	932,787
Holland	693,339	356,402	412,163	208,146
Belgium	63,046	17,274	36,904	10,244
France	1,350,178	124,644	690,532	73,174
Other Countries	69	192,732	81	96,700
Total Refined Sugars	6,064,581	2,493,741	3,261,103	1,321,051
Molasses	190,960	240,553	44,416	48,113
Total Imports	10,606,179	4,541,819	4,985,881	2,110,743

EXPORTS.

British Refined Sugars.	Cwts.	Cwts.	£	£
Sweden and Norway	7,747	3,189	4,843	1,660
Denmark	26,940	13,104	14,985	6,625
Holland	8,697	10,274	4,750	5,577
Belgium	2,022	1,745	1,684	843
Portugal, Azores, &c.	2,387	1,125	1,312	579
Italy	3,974	1,648	1,927	765
Other Countries	62,591	61,586	41,285	37,778
	114,358	92,671	70,186	53,827
Foreign & Colonial Sugars.				
Refined and Candy	4,030	3,348	2,948	2,362
Unrefined	12,343	5,906	6,278	3,062
Molasses	431	29	161	24
Total Exports	131,162	101,954	79,573	59,275

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1903. Tons.		1902. Tons.
Total Receipts, 1st Jan. to March 19th ..	300,258	..	287,836
Receipts of Refined ,, ,, ,, ..	212	..	2,352
Deliveries ,, ,, ,, ..	286,016	..	296,842
Consumption (4 Ports, Exports deducted) since 1st January	267,434	..	296,859
Importers' Stocks (4 Ports) March 18th..	18,627	..	16,305
Total Stocks, March 25th	185,000	..	116,187
Stocks in Cuba ,, ...	312,000	..	351,136
	1902.		1901.
Total Consumption for twelve months ..	2,566,108	..	2,372,316

CUBA.

STATEMENT OF EXPORTS AND STOCKS OF SUGAR, 1902 AND 1903.

(Tons of 2,240lbs.)	1902. Tons.		1903. Tons.
Exports	50,324	..	97,300
Stocks	292,608	..	263,779
	342,932	..	361,088
Local Consumption (two months)	7,650	..	7,730
	350,582		368,818
Stock on 1st January	19,873	..	42,530
Receipts at Ports up to 28th February..	330,709	..	326,288

J. GUMA.—F. MEJER.

Havana, 28th February, 1903.

UNITED KINGDOM.

STATEMENT OF IMPORTS, EXPORTS, AND CONSUMPTION FOR THREE YEARS.
From *Produce Markets' Review.*

SUGAR.	Imports 1903. Tons.	Imports 1902. Tons.	Imports 1901. Tons.	Exports (Foreign) 1903. Tons.	Exports (Foreign) 1902. Tons.	Exports (Foreign) 1901. Tons.
Refined, Jan. 1st to Feb. 28th	124,687	303,229	165,501	167	201	872
Raw, ,, ,,	90,376	217,532	135,362	295	617	924
Molasses, ,, ,,	12,027	9,548	15,599	1	21	408
Total	227,090	530,309	316,462	463	839	2,204

HOME CONSUMPTION.

	1903. Tons.		1902. Tons.		1901 Tons.
Refined, Jan. 1st to Feb. 28th........	116,562	....	308,681	....	——
Raw, ,, ,, ...	81,651	....	238,127	....	——
Molasses, ,, ,, ...	11,234	....	11,430	....	——
Total	209,447	....	558,238	....	——
Less Exports of British Refined	4,633	....	5,717	....	——
Net Home Consumption of Sugar	204,814	....	552,521	....	290,897*

* Trade estimate.

Stocks of Sugar in Europe at uneven dates, March 1st to 25th, compared with previous Years.

In thousands of tons, to the nearest thousand.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	Total 1903.
109	1245	777	576	164	2972

	1902.	1901.	1900.	1899.
Totals	3130 ..	2474 ..	2290 ..	2256

Twelve Months' Consumption of Sugar in Europe for Three Years, ending February 28th, in thousands of tons.

Great Britain.	Germany	France.	Austria.	Holland, Belgium, &c.	Total 1902-03.	Total 1901-02.	Total. 1900-01.
1476	849	561	412	533	3831	4228	4181

Estimated Crop of Beetroot Sugar on the Continent of Europe for the current Campaign, compared with the actual crop of the three previous Campaigns.

(From Licht's Monthly Circular.)

	1902-1903. Tons.	1901-1902. Tons.	1900-1901. Tons.	1899-1900. Tons.
Germany	1,750,000 ..	2,304,924 ..	1,984,186 ..	1,798,631
Austria	1,070,000 ..	1,302,038 ..	1,094,043 ..	1,108,007
France	890,000 ..	1,183,420 ..	1,170,332 ..	977,850
Russia	1,215,000 ..	1,098,983 ..	918,838 ..	905,737
Belgium	230,000 ..	334,960 ..	393,119 ..	302,865
Holland	105,000 ..	203,172 ..	178,081 ..	171,029
Other Countries.	345,000 ..	393,236 ..	367,919 ..	253,929
	5,605,000	6,820,733	6,046,518	5,518,048

THE

INTERNATIONAL

SUGAR JOURNAL.

No. 53. MAY, 1903. Vol. V.

☞ All communications to be addressed to The Editor, Office of *The Sugar Cane*, Altrincham, near Manchester.

All Advertisements to be sent *direct*.

Cheques and Postal Orders to be made payable to Norman Rodger, Manchester.

☞ The Editor is not responsible for statements or opinions contained in articles which are signed, or the source of which is named.

The Budget and the Sugar Tax.

The 1903 Budget, made public on April 23rd, has not, as some were inclined to expect, brought about any alteration in the tax levied on sugar last year. It remains unaltered, and doubtless this was the wisest course to pursue. No authentic proof has yet been advanced to show that this tax has pressed heavily on one or other section of the taxpayers. Allegations have, it is true, been made to that effect in obviously biassed quarters, but a cursory examination of the points advanced has invariably shown that the complainants would have to look elsewhere for the real explanation of their losses. To take a case in point, we have had a mineral water manufacturer writing to the press and complaining that his firm's profits for last year were (if we remember aright) some 300% less than a year or two previously; he blamed the sugar tax for this unusual fall. Now it must be noted that since 1900 the average price of sugar has been steadily falling, so that this commodity was cheaper in 1901 than in 1900, and in 1902 in spite of the imposition of sugar tax, the price fell even lower than it had done in 1901, so that the only influence the sugar tax had on prices was to keep them at about the same level as in the previous year, but lower than in 1900, when the above firm claimed to have made such large profits. Under the circumstances one is at a loss to understand by what process of reasoning this decrease in profits can be laid at the door of the tax on sugar. The probably truer cause was that the unusually damp and cold summer occurring in this country in 1902 had greatly reduced the demand for mineral waters.

There is not much to chronicle with regard to Sugar Convention matters. The Bill to give full assent to the Convention on the part of Great Britain has yet to be introduced into the House of Commons, but possibly before our next issue appears, it will have been disposed of. Some opposition is naturally to be looked forward to, but there should be no difficulty in passing the measure, particularly as Mr. Chamberlain will be practically responsible for its success, and may be expected to make an effective speech in its support.

The United States and the Brussels Convention.

Attention has been drawn to the fact that unless the U.S.A. decides to become a party to the Brussels Convention she will, failing the reduction of her present tariff on sugar to the six francs surtax scale, be liable to have her sugar countervailed in the event of its being exported to those countries which are parties. This is a matter which will doubtless have to be considered by the U.S. Treasury, as, if not now, at any rate in the near future, America will be in a position to become an exporter of sugar, and the British market would be a likely goal for it. There are plenty of indications that the Dingley Tariff will sooner or later have to be modified; it is no doubt an excellent institution when one country has the monopoly of working it, but when two or three countries show that they too can adopt the same tactics, it becomes an open question as to whether the game is worth the candle.

The British Delegates on the Brussels Commission.

The International Commission of the Brussels Sugar Convention will, as our readers probably know, meet not later than the 1st of June next. The British delegates are to be: Sir Henry Bergne, C.B., K.C.M.G., Delegate; Mr. A. A. Pearson, C.M.G., and Mr. T. J. Pittar, C.B., Assistant Delegates; with Mr. George Martineau, C.B., as Expert Adviser.

French Preserves.

It is stated that efforts are being made in France to secure increased protection for French preserves at the expense, no doubt, of the English article. Evidently the French refiners, having lost the English market (thanks to the action of the German and Austrian Cartels), are trying to find an outlet for their sugar by encouraging their own preserve industry at the very natural expense of foreign (chiefly British) manufacturers. Very likely the leaders of the Confectioners' agitation will bring forward this item as another proof (?) of the undesirability of abolishing bounties, but it is only one possible result which, as we forecasted some time ago, might be expected to ensue when Continental nations desired to find further outlets for their sugar.

Steam Wagons in Mauritius.

With regard to the steam wagons lately imported into Mauritius, enquiries among the planters who use them have elicited the information that, according to a general consensus of opinion, they are not altogether suitable for the transport of cane on plantation roads; transport improvements are now taking the form of light railways of 2 ft. 6 in. to 3 ft. gauge, of which very large quantities are on order for the coming crop (August, 1903). Where the steam wagons have come in extremely useful is in the transport of sugar from the factory to the railway; a proportion of the estates are near the railways, and have sidings running into the factory yard, but a number lie at a considerable distance, up to twelve or thirteen miles.

A steam wagon will carry a six-ton load at eight miles an hour; a mule will only transport half a ton at three miles an hour; a steam wagon is thus equal to at least thirty mules. The wagon landed in Mauritius costs approximately £1,000; mules on the average cost £40 per head, and in addition there is the cost of feeding the stock, the labour in attendance in transport, and the risk of mortality from disease, which are all points in which the mechanical traction scores. The plantation roads must be seen to be appreciated; they are very narrow, very uneven, and have very sharp turns and steep gradients, and by some persons the mechanical traction is not considered suitable for them.

The scheme of light railway transport is generally as follows:—The centre of cultivation is transversed by a trunk line; the latter is fed by moveable lines, which are removed from time to time as different sections are harvested; out of crop time the lines are still used in the transport of manures, tops, &c.

The values of imports of raw and refined sugar into Canada for six months ending December, 1902, were as follows:—

	Dols.
Refined—	
From England	57,758
,, U.S.A.	79,936
,, Germany	420,985
,, Holland	26,757
,, Other Countries	33,836
	619,272
Raw—	
From England	—
,, U.S.A.	6,470
,, Germany	1,662,165
,, Belgium	51,499
,, British West Indies	337,551
,, Other Countries	842,831
	2,900,516

THE COST OF PRODUCTION OF BEETROOT SUGAR IN GERMANY.

In the paper read before the Royal Statistical Society on the 18th April, 1899, I gave some calculations of the cost of production of beetroot sugar in Germany. It may be interesting to give later statistics on the same point; the more so, now that with the abolition of bounties the cost of production will be the main factor governing production and price.

The yield of sugar from the roots varies, in different countries and seasons, between 12 and 14 per cent. These are equivalent to the following quantity of roots per cwt. of sugar:—

12% = 8·33 cwts. of roots per 1 cwt. of sugar.
13% = 7·692 ,, ,, ,,
14% = 7·143 ,, ,, ,,

The Paris *Journal des Fabricants de Sucre* of the 8th April, 1903, quotes figures given by Herr Ernst Glantz of the results of 33 German factories in the year 1901-2, from which it appears that the average cost of manufacture for these 33 factories can be calculated as follows:—

	Pfennigs.		Per Cwt. of Roots. d.
Average price of roots	88	=	10·56
Average cost of manufacture	38·7	=	4·644

The average yield in Germany now varies between 13 and 14 per cent.

If we take an average yield of 13 per cent. of sugar from the roots (= 7·7 cwt. of roots per cwt. of sugar) we get:—

		d.		s. d.	
7·7	×	10·56	=	6 9¼	per cwt of sugar.
7·7	×	4·64	=	2 11¾	,, ,,
Total cost of 1 cwt. sugar in the factory ..				9 9	

If we take the higher average yield, an exceptional one, of 14 per cent., the calculation comes out:—

		d.		s. d.	
7·14	×	10·56	=	6 3½	per cwt. of sugar.
7·14	×	4·64	=	2 9	,, ,,
Total cost of 1 cwt. sugar in the factory ..				9 0½	

The figures for the last five seasons are given as follows:—

	Cost of Roots per Cwt. Pfennigs.		d.		Cost of Manufacture per Cwt. of Roots. Pfennigs.		d.
1897-8	89	=	10·68	..	40	=	4·8
1898-9	96·5	=	11·58	..	42·3	=	5·076
1899-00	96·45	=	11·57	.	45·3	=	5·436
1900-1	101·4	=	12·16	..	42·3	=	5·076
1901-2	88	=	10·56	..	38·7	=	4·644
Average			11·31		Average ..		5·006

Taking this average we get, on the basis of a yield of 13 per cent.:—

			s.	d.	
7·7 ×	11·3 d.	=	7	3	per cwt. of sugar.
7·7 ×	5	=	3	$2\frac{1}{2}$	,, ,,
	Total cost ..		10	$5\frac{1}{2}$	

or, on the basis of an exceptional yield of 14 per cent.:—

			s.	d.	
7·14 ×	11·3 d.	=	6	$8\frac{3}{4}$	per cwt. of sugar.
7·14 ×	5	=	2	$11\frac{3}{4}$	,, ,,
	Total cost ..		9	$8\frac{1}{2}$	

An examination of how the cost varies in different factories may also be interesting. Thus, of the 33 factories, the one which paid the highest price for roots paid 106 pfennigs per cwt., while the lowest price paid was 69 pfennigs. The highest cost of manufacture was 68 pfennigs, and the lowest 28 pfennigs per cwt. of roots.

The factory which had the high cost of working of 68 pfennigs per cwt. of roots, worked 42,000 tons of roots. There were ten factories which worked smaller quantities, but their average cost of manufacture came to only 42 pfennigs, so that this particular factory must be an exceptional case and should be disregarded. The factory with the lowest cost of manufacture was capable of working and actually worked 139,000 tons of roots. But two factories with a still larger capacity had a cost of manufacture of 30 and 32 pfennigs.

In fact, a careful examination of the figures for the 33 factories shows that size of factory is not by any means an invariable measure of the cost of manufacture. Thus we can find several small factories which worked below the average cost of 38 pfennigs, and an equal number of large ones that worked at as high and even a much higher figure. Here are five of each kind:—

Tons of roots worked.		Cost of manufacture per cwt. of roots. Pfennigs.	Tons of roots worked.		Cost of manufacture per cwt. of roots. Pfennigs.
40,137	....	30	96,891	....	38
33,950	....	34	61,253	....	41
26,360	....	35	52,900	....	43
26,000	....	35	69,500	....	47
26,720	....	36	46,810	....	49

It is clear that the cost of production of beetroot sugar varies within very wide limits even in Germany, where it has been reduced to its present minimum. The fluctuations in the cost of roots, cost of manufacture, and yield of sugar are considerable, and therefore if the above figures be correct it is impossible to put the average German cost of production of beetroot sugar at less than from 9s. to 10s. per

cwt., to which has to be added the freight from the factory to Hamburg, warehousing charges, and expenses of putting f.o.b.

That the cost of production in France, Austria, and Russia is considerably higher is, I think, generally admitted. But those countries, having room for improvement, will no doubt continue to progress, and two of them will probably succeed in reaching the perfection arrived at in Germany.

GEORGE MARTINEAU.

THE RISE AND FALL IN THE PRICE OF SUGAR DURING THE PERIOD 1882-1902.

As a great deal is said nowadays by the opponents of the Brussels Sugar Convention of the prospective rise in price consequent on the abolition of bounties, it is instructive to note what effect the bounties themselves have had, directly or indirectly, on the prices of sugar during the last 20 years. We therefore submit below the highest and lowest annual price for German 88% Beet for the years 1882 to 1902.

	Highest.		Lowest.		*Fluctuation.*	
	s.	d.	s.	d.	s.	d.
1882	23	6	19	10	3	8
1883	21	6	19	1	2	5
1884	19	3	10	1	9	2
1885	16	10	10	8	6	2
1886	15	10	10	6	5	4
1887	16	3	10	5	5	10
1888	16	0	12	5	3	7
1889	**26**	**11**	11	6	**15**	**5**
1890	14	3	11	6	2	9
1891	14	$10\frac{1}{2}$	12	$3\frac{3}{4}$	2	$6\frac{3}{4}$
1892	14	$10\frac{1}{2}$	12	6	2	$4\frac{1}{2}$
1893	18	$11\frac{1}{4}$	12	3	6	$8\frac{1}{4}$
1894	13	$2\frac{1}{4}$	8	$6\frac{3}{4}$	4	$7\frac{1}{2}$
1895	11	0	8	6	2	6
1896	12	9	8	$8\frac{1}{4}$	4	$0\frac{3}{4}$
1897	9	$9\frac{3}{4}$	8	3	1	$6\frac{3}{4}$
1898	10	$2\frac{1}{4}$	8	$11\frac{3}{4}$	1	$2\frac{1}{2}$
1899	11	$3\frac{1}{2}$	8	$11\frac{3}{4}$	2	$3\frac{3}{4}$
1900	12	$4\frac{1}{4}$	9	$0\frac{1}{4}$	3	4
1901	9	7	6	$6\frac{1}{2}$	3	$0\frac{1}{2}$
1902	8	$4\frac{3}{4}$	**5**	**$10\frac{1}{2}$**	2	$6\frac{1}{4}$

ON THE "RIND" DISEASE OF THE SUGAR CANE IN THE WEST INDIES.

By Albert Howard, M.A., F.L.S.,

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During the years 1899-1902 I had occasion to study some of the diseases of economic plants in the West Indies, including that known as the "rind" disease of the sugar cane. A technical account (7), with illustrations, of this malady, embodying the results of my investigations, is to be found in the *Annals of Botany* of March, 1903. In the same memoir, the common root disease of the sugar cane in the West Indies is discussed, and a list of the more important papers relating to these diseases is given.

In the present paper it is proposed to deal with the cause of the "rind" disease, and especially with the possible remedial and preventive measures to check the damage done thereby. In a second paper it is hoped to consider this root disease of the cane in a similar manner.

Characters of the Disease.

Canes attacked by the "rind" disease have a very characteristic appearance. The disease appears about four or five months before the canes are cut, generally at the beginning of the ripening period. It makes its appearance earlier in first crop canes than in ratoons, and attacks sweet canes like the Bourbon to a much greater extent than some of the seedlings. These latter, however, are by no means immune, and in no case was a seedling cane found which was entirely free from the disease. The White Transparent, a variety much cultivated in Barbados at the present time, is often affected. The first outward symptom of the malady is the drying-up of the leaves, which commences at the margins of the older ones, and gradually spreads to the centre of the tuft in from four to six weeks. When this drying of the leaves is well marked, the stem of the cane shows a brown discoloration in one or more places, after which the rind shrivels up, and the discoloration rapidly extends in all directions. On splitting such canes in half, the tissues are seen to be of a reddish colour, in which darker red areas can be seen. Very frequently these darker regions contain definite white centres, elliptical in vertical section. The appearance (Fig. 2) coincides exactly with that originally figured by Went (2, 4) in his writings on the "Red Smut" disease of the cane in Java, and later by Barber (5) in the case of the same disease in Madras.

Infection seems to take place in many cases at the tunnels made by boring insects, such as the moth borer (*Diatraea saccharalis*, Fabr.),

but in a good many instances it appears to have started at the old leaf bases.

Two fungi are very common on such diseased canes—the *Melanconium*, described and figured by Massee (1) as a phase of his *Trichosphaeria Sacchari*, and a second form which is not very often seen in the earlier stages. The former fungus appears to the naked eye as black, hair-like filaments, bursting through the rind of the cane. These filaments are composed of an immense number of spores, loosely cemented together. The latter form occurs as minute, black, velvety, star-shaped patches on the outside of the cane, generally just below the leaf-base, or on the sleeping roots above the node (Fig. 1). These bodies are spore patches bearing dark hairs, near the base of which crescent-shaped spores are formed. The reddish-coloured tissue in the interior of the cane contains colourless mycelium, in which the contents appear as a row of circular oily drops. In the older portion of the affected tissue, dark-brown resting spores are to be seen in the hyphae. All these appearances agree with the fungus causing the "Red Smut" disease of the sugar cane in Java, described by Went (2, 4).

Canes attacked by this disease give rise to considerable trouble in the factory. Not only is the sucrose content of the juice of these canes extremely low, but impurities are present in such amount as to render the presence of such canes very undesirable. They are thus useless in themselves, and also contaminate, and lower the quality of the juice of the sound canes of the sample. Those diseased canes which are greatly discoloured and partly drying up are known locally as "rotten" canes, and are thrown aside, and thus escape crushing with the rest. When the disease is not so advanced, and can only be discovered by splitting the cane in two, the workman is unable to detect it. Consequently, such canes are crushed with the rest, and thus lower the purity of the juice.

In reaping the experimental plots in Barbados it is customary to weigh the obviously diseased canes separately and return them as "rotten cane." The proportion of these diseased canes is supposed to be an index of the disease resisting power of the variety. As will be shown below this idea is hardly in accordance with the facts of the case.

Cause of the Disease.

In the first instance an extended study of the *Melanconium* fungus so common on these diseased canes was undertaken with a view of determining its possible relationship with other forms sometimes met with on such canes, and also whether it behaves as a parasite towards the sugar cane and thus causes the "rind" disease. The final results of this study were negative, and are to be found in a previous paper (7). They need not be given in detail here. Briefly stated, it was found that this fungus is not a parasite, and is not the cause of

the "rind" disease. Further, no connexion between this form and the other fungi met with on the sugar cane was obtained by the methods of pure culture. An opportunity of repeating these experiments in England lately presented itself. Thanks to the kindness of Professor Marshall Ward, I was able to study this fungus at Cambridge, and to carry out inoculation experiments on mature sugar cane in the Lily House at the Botanical Gardens there. The results, under these conditions, were identical with those obtained in Barbados. *Melanconium* did not behave as a parasite towards the cane, neither was any connexion between it and other sugar cane fungi obtained in pure cultures of this form.

An examination of the other fungus referred to above found on canes attacked by the "rind" disease gave decisive results. A detailed study of the behaviour of this form, when grown in pure culture, was first undertaken. A beginning was made with a spore obtained from one of the star-shaped spore patches shown in Figure 1. Germination takes place in a few hours (Fig. 3) especially when the food material was composed of:—

Cane Extract..	100 c.c.
Gelatine	15 grams.
Tartaric Acid..	·2 gram.
Peptone	·5 gram.

Under these circumstances the subsequent development of the fungus is also very rapid.

Spores are formed in great numbers from the mycelium by a process of budding about the third day. Stages in their production are shown in Fig. 4. These spores are smaller ($25 \times 2{\cdot}5\mu$) than those formed at the spore-patches on the exterior of the cane, and are identical with those produced in large numbers when a piece of fresh cane attacked by the "rind" disease is split open and placed in a moist chamber.

When five days old, dark brown resting spores (Fig. 5), similar to those noted in the older portion of the cane when attacked by this disease, were found. Lastly spore patches, similar to those seen on the outside of the cane, were noted when the cultures were six days old. These gave rise to crescent-shaped spores similar to that started with. Their formation is illustrated in Fig. 6.

In addition to these small hanging-drop cultures, in which the development of the fungus could be studied under the microscope from one spore, many large cultures were also made and the growth of the fungus observed. Similar results to those described above were in all cases obtained. The development of the fungus on the cane and in artificial media was therefore identical.

A large number of inoculation experiments with pure cultures of this fungus was then made on healthy sugar canes. The following account of this part of the work is taken from my previous paper (7) on this subject:—

1. On December 4, six healthy canes in the same stool were inoculated at wounds made in internodes about the middle of the stem and also at upper leaf-bases, with spores from a pure culture of the fungus. Precautions to prevent the entry of other spores were taken, and six other canes were used as controls. On December 10, one of the inoculated canes showed that infection was taking place at the wound, but no result was observed at the leaf-base. On December 16, a second cane was examined, when distinct infection was observed in the tissues of the internode where the wound was made and also at the upper leaf-base. On December 26, two more canes were examined. No infection was detected at the leaf-bases, but at the wounds very definite indications of the "rind" disease were noted. The leaves were beginning to dry in the characteristic manner, and on splitting open the canes infection was apparent in four of the internodes, where the red blotches, with white centres, were evident. The invading mycelium was characterized by its branching and oil-drops, and agreed exactly with that seen in canes attacked by the "rind" disease. The remaining two canes were also drying at the top and were obviously infected at the wounds. They were used for the experiments with *Melanconium*, described below. In this experiment one of the controls became infected with the fungus; the other five gave negative results.

2. On December 10, six canes were inoculated in a similar manner to those in the above experiment, and six others were used as controls. On December 28, one of the inoculated canes showed infection at the wound, but not at the leaf-base. On January 22, two of the inoculated canes showed that at the wounds the fungus had invaded two of the internodes, and had produced the characteristic red blotches with white centres. In one case infection had also taken place at a leaf-base. The other three canes in which infection at the wounds was very evident, were used for the experiments with *Melanconium*, described below. The control canes gave negative results.

3. On December 19, four canes were doubly inoculated at wounds made in an upper and a lower internode, with mycelium from a pure culture of the fungus. As before, controls were employed, and precautions taken to introduce only one fungus. The object of this experiment was to determine the comparative effect of the fungus on those portions of the cane which are very rich and very poor in sugar. On January 22, a cane was examined, when it was found that the fungus had invaded 16 inches of the upper part, which showed the characteristic markings, but had not spread beyond the internode at the lower wound. The remainder of the canes were examined five days later. In all cases infection had taken place to about the same extent, the length of cane affected varying from 18 to 24 inches. The characteristic red blotches with white centres were abundant.

4. On December 31, four canes were inoculated with spores from a pure culture of the fungus as follows: In two cases the canes were doubly inoculated at upper and lower leaf-bases, and in the other cases at wounds in upper and lower internodes. Two control canes were also used. On January 22, the canes which had been inoculated at leaf-bases showed that infection had taken place at both the upper nodes and at one of the lower nodes. At the upper part of both canes the star-shaped spore patches of the fungus were abundant on the affected rind at the nodes above and below the point of inoculation. In each case about 9 inches of the cane were affected, and the red blotches were abundant. A similar result was observed in the case of the cane where the fungus had also infected at a lower node, but no spore patches were evident on the rind. On January 23, the canes inoculated at wounds showed that in all cases infection had taken place, and spore patches had formed on the outside at the upper affected regions. From 12 to 18 inches of the cane were invaded at each wound. The controls gave negative results.

The above inoculation experiments were carried out with canes during the ripening period, and after active growth in size had ceased. The results obtained, while indicating that the fungus is a wound parasite, nevertheless do not conclusively show that it is capable of overcoming tissues still capable of growth and development. Accordingly, further experiments were made on first-crop canes, about six months old, which were in a vigorous state of growth. In all cases inoculation was performed in developing internodes which were then not more than 1 inch in length. The experiments were as follows:—

5. On June 20, three young canes were inoculated by placing seven days old, actively growing, mycelium, from a pure culture in the sugar-cane extract medium, into wounds made in the centre of a lower internode, then about three-quarters of an inch in length. Care was taken to introduce only one fungus, and to shut off the apertures from the air by means of sterilized waxed tape. Three similar canes were used as controls. Two months afterwards the canes were examined. In the first case, the affected internode had grown to 2½ inches in length, and on splitting open the cane this and the internode below were found to be generally reddish in colour with the elliptical white areas, characteristic of the "rind" disease, well represented. About 4 inches of the cane were invaded by mycelium, which agreed with that of the fungus which had been introduced. A closely similar result was obtained in the other two inoculated canes, but the controls showed no infection.

6. On June 23, the above experiment was repeated on two similar canes. Two months afterwards two internodes were, in each case, found to be completely invaded by the fungus which had produced all the characters of the "rind" disease.

7. On June 27, four canes about six months old, growing in tubs, were inoculated with pure cultures of the fungus, three at wounds in the internodes, the other at a leaf-base. On August 19, one of the canes inoculated at a wound exhibited the characteristics of the "rind" disease in the infected internode, but the other three and the controls gave negative results.

8. On June 23, three vigorous canes about six month old, growing in the field, were inoculated at leaf-bases, from which the adhering green leaves had been torn, with six days' old mycelium from a pure culture. Afterwards the nodes were covered with sterile waxed tape. On August 19, one of the canes gave a negative result, but the other two showed distinct infection. In one case, 5 inches of the cane were invaded, in the other about $2\frac{1}{2}$ inches.

These experiments show conclusively that the fungus is capable of more than mere wound parasitism. It is able to overcome tissues capable of active growth. At the same time it can thrive readily as a saprophyte in artificial media and pass through its whole development thereon. It occurs in the West Indies every ripening season as a parasite. It would seem to be therefore intermediate between a hemi-saprophyte and a hemi-parasite and not to belong strictly to either of these classes.

Further, it is clear that this fungus and not *Melanconium* is the cause of the "rind" disease of the sugar-cane.

On referring this fungus to its systematic position it is evident that, in the absence of any higher fructifications than those described, it must be placed in the *Fungi Imperfecti* and that it falls into Corda's genus *Colletotrichum*. From its characters and its parasitism on the sugar-cane it evidently agrees with *C. falcatum*, Went (2, 4), a form which causes the "Red Smut" disease of the sugar-cane in Java.

Thus the "rind" disease of the West Indies and the "Red Smut" of Java are identical. This conclusion was strengthened by the examination of specimens of sugar-cane, said to be attacked by "rind" disease, from other parts of the West Indies and Surinam. In all cases the characters of the disease were identical with those given above, and most of the specimens showed both *Melanconium* and *Colletotrichum*. Further, careful examination of many of the cane-fields of St. Vincent in January, 1902, where the Bourbon is almost exclusively cultivated and where the "rind" disease makes its appearance every year in December, showed that the disease was identical with the "Red Smut" and that the fungus *Colletotrichum falcatum* was present.

The fungus appears to be widely distributed. In addition to the West Indies it occurs in Java, Madras (5) and also in Queensland (6).

Since *Melanconium* always appears on canes attacked by the "rind" disease it seems probable that it must infect the canes after they are diseased. Accordingly the effect of this fungus on a part of the

sugar-cane attacked by *Colletotrichum* was compared with its effect on the still healthy portion. The experiments were as follows :—

1. Two canes which had been inoculated on December 4 with spores of *Colletotrichum*, and which showed from the outside that infection had taken place, were reinoculated on December 21 at the affected region and also near the base, in the still healthy tissue, with spores of *Melanconium* from a pure culture. On January 23, it was found that at the upper part numerous filaments of *Melanconium* had developed, but at the base infection had not taken place.

2. On December 19, three canes, which had been inoculated at the upper parts with spores of *Colletotrichum* nine days previously, were reinoculated with *Melanconium* spores from a pure culture. A second inoculation with these spores was made at the base of these canes in the still healthy portion. On January 27, *Melanconium* filaments were evident round the upper wounds, but no infection had taken place below.

These experiments show that the part played by *Melanconium* in the "rind" disease of the sugar-cane is that of a follower of *Colletotrichum*, and that it only invades previously diseased canes.

Remedial and Preventive Measures.

The nature of the "rind" disease having been determined, it became possible to consider the question of how far its ravages may be diminished and prevented. It is then that the real difficulty in such matters is encountered. It is usual when the diseases of economic plants are studied for the investigator to base recommendations of a remedial nature on the results of his researches. These are published for the information of the planter, who is supposed to adopt them in practice. Only on very rare occasions does the practical agriculturist pay any attention to this advice. For this attitude he is unjustly blamed by his would-be advisers. A little consideration will show that the scientific investigator and not the planter is in the wrong. If the investigation of plant diseases has any economic value, it should be possible to demonstrate this to the practical man. In any given disease therefore, the investigator should test the value of his own advice by experiments on a sufficiently large scale on the estates themselves, and then lay the results of such trials before the planters. This proceeding is especially necessary in the case of fungoid diseases as their nature is not always clearly perceived by agriculturists. Unless therefore these trials are carried out in an adequate manner it is hopeless and perhaps even unreasonable to expect any practical results to follow from investigations on plant diseases.

The necessity of conducting such large scale experiments as those indicated above was clearly impressed upon my mind while temporarily employed by the Imperial Department of Agriculture for the West Indies. The planters were willing and even anxious that such work

should be done, and several placed their estates at my disposal for the purpose. Unfortunately, however, an unexpected difficulty arose which put the proposed experiments out of the question, and the suggestions could not be carried out. It is gratifying to notice, however, that the principle outlined above has been already applied in another direction in one locality in the West Indies in connection with sugar cane investigations. I refer to the large area tests of new seedling varieties of promise lately instituted in the British Guiana sugar estates. The credit of having carried out this reform belongs to Professor Harrison. There can be no doubt that in the case of cane diseases a similar method might be adopted before any real results can be achieved.

In the absence of data obtained on the estates themselves, all that can be done is to indicate the lines on which such trials might be conducted. For convenience, these are discussed separately.

1. *The destruction by burning of the diseased canes at reaping time.*—There can be no doubt that the "rotten canes" are covered with the spores of the "rind" fungus, and that they are capable of infecting healthy canes. On general grounds, therefore, they should be destroyed. The Java method of pouring kerosene oil on a heap before igniting it, would seem to be a practicable method of getting rid of this diseased material. It would be easy to conduct experiments to show the amount of damage done when the "rotten canes" are left on the ground. Fields of young canes could be selected, on the lee-ward half of which diseased canes could be scattered, leaving the windward half clear. The amount of "rind" disease in both cases could be compared, and data would be available to show whether or not it really pays to carry out this recommendation.

2. *The early reaping of fields in which the "rind" disease makes its appearance to any considerable extent.*—The planter is here confronted with a problem which can only be solved by large scale experiments. On the one hand, the canes improve in quality as they ripen. On the other hand, the fungus is spreading, destroying larger and larger amounts of sugar, and giving rise to impurities which will affect the juice of the healthy canes. The question to be answered is, whether it is better to reap early when the canes are not perfectly ripe, and when there is little disease, or at the usual period, when the canes are riper, but when the disease is much further advanced. It would be easy to reap one half of a diseased field early and the rest later, and to compare yield of sugar with tonnage of canes in both cases. An advantage of early reaping would be that the fungus at this stage would not have formed spores, and would be destroyed in the megass before it could spread to other canes.

3. *Removal of the dead leaves of the cane during the period of growth.*—There would seem to be several advantages in this proceeding. The atmosphere round the cane stems would be rendered much drier,

and the chance of infection by the spores of the "rind" fungus would be diminished. The drying of the canes by evaporation of water through the rind could also be promoted and the work of concentrating the juice lessened. Since several parasitic fungi often occur on the old leaf sheaths and leaves it would be interesting to find whether it would pay to burn the old leaves when they are removed. The value of this stripping of the canes could easily be decided by suitable experiments.

4. *The use of the best cuttings as plant material.*—Much advice has been given to the West Indian planters on this question, but the matter does not seem to have received that amount of experimental attention it would seem to deserve. The produce obtained by planting the best cuttings could easily be compared with that resulting from poor and diseased plant material and the value of both crops determined.

5. *The control of boring insects.*—As the "rind" fungus is often a wound parasite, and gains access to the canes at the tunnels made by boring insects such as the moth-borer, it is clear that steps should be taken to limit the damage done by these pests. In the West Indies the eggs of the moth-borer are laid on the leaves of the canes and are destroyed in large numbers by a small fly which lays its own eggs in those of the borer and thus destroys these latter. The collection of the eggs of the borer during the early period of growth of the canes is quite practicable, and besides is not an expensive proceeding. If all these eggs, many of which contain the larvæ of the small fly referred to above, were allowed to hatch in the cane-fields in such a manner as to ensure the destruction of those which are normal, while at the same time all the parasites are preserved, the pest would be diminished, and its natural enemy increased. Zehntner's method of placing the egg clusters in a dish standing in a wider outer vessel containing molasses, the whole being encased in netting, would seem to be a practicable suggestion for the cane-fields of the West Indies. By this device the larvæ of the borer are destroyed as they crawl into the molasses after hatching from the egg, while the flies escape and destroy further egg colonies on the leaves. This measure as well as that of cutting out and burning dead-hearts containing developing larvæ, if carried out systematically, should tend to diminish the damage done by the moth-borer, and also indirectly that wrought by the "rind" fungus.

One further point deserves mention. In the early part of the present article it is stated that the amount of "rotten cane" left when the crop is reaped is not an accurate index of the disease-resisting capacity of the particular variety cultivated. It is only an imperfect indication of the amount of the "rind" disease present. Many of the other fungoid diseases of the cane are represented not by "rotten cane," but by a diminished tonnage of apparently normal cane. This is especially the case with the destructive root disease of the cane so

common in Barbados. An example will make this point clearer. The seedling B 147 seldom contains much "rotten cane," as it is attacked by the "rind" disease to only a limited extent. It is, however, prone to root disease, especially in the second crop; so that although it yields few rotten leaves, nevertheless it is far from being immune to fungoid disease.

In conclusion, I wish to express my indebtedness to the Editors of the *Annals of Botany* for their kind permission to reproduce, from No. 64 of that Journal, the figures which illustrate this paper. Mr. Eric T. Molecey has been good enough to copy these drawings for reproduction in the present paper.

Summary of Conclusions.

1. The "rind" disease of the sugar cane in the West Indies is identical with the "Red Smut" disease of Java, and is caused by the fungus *Colletotrichum falcatum*, Went. It can infect ripening canes at wounds and at old leaf-bases, and can overcome the tissues of young canes which are capable of growth and development.

2. The *Melanconium* found on diseased sugar canes in the West Indies is a saprophyte, and is not the cause of the "rind" disease. It infects canes easily at points when they have been invaded by *Colletotrichum*.

3. The directions in which experiments should be conducted, on an estate scale, to test the value of remedial and preventive measures against this disease, appear to be as follows:—

(*a*.) The destruction by burning of the diseased canes at reaping time.

(*b*.) The best time to reap fields in which the rind disease makes its appearance to any considerable extent.

(*c*.) Stripping the growing canes.

(*d*.) Planting from the best cuttings.

(*e*.) The control of boring insects.

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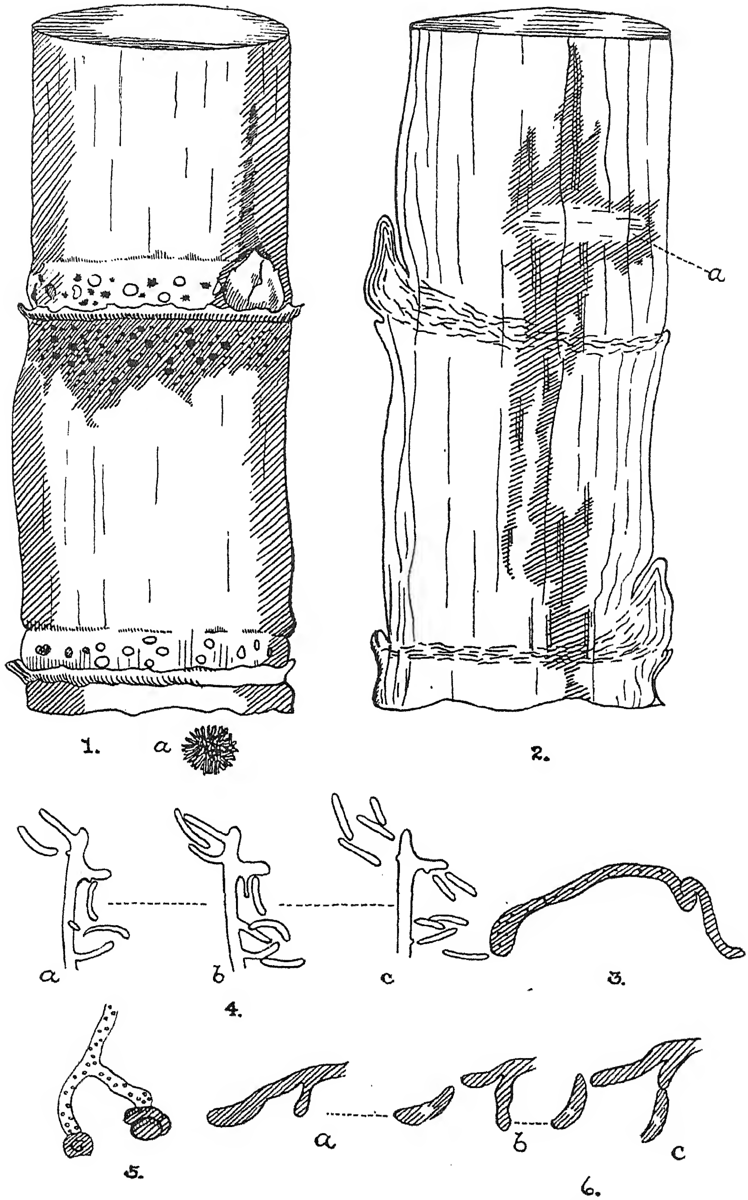

THE "RIND" DISEASE OF THE SUGAR-CANE IN THE WEST INDIES.

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EXPLANATION OF PLATE.

FIG. 1.—A portion of the stem of a sugar cane attacked by the "rind" disease, showing spore patches of *Colletotrichum falcatum* above and below the leaf base. Natural size. At (*a*) one of the spore patches is represented as seen under a lens.

FIG. 2.—A portion of the stem of a sugar cane attacked by the "rind" disease split in half. A red blotch with a white centre is shown at (*a*). Natural size.

FIG. 3.—A germinating spore of *Colletotrichum falcatum* × 375.

FIG. 4.—Stages in the formation of spores from the mycelium of *Colletotrichum falcatum*, in a hanging-drop culture:—

$$\left.\begin{array}{l} a = \text{12-45 p.m.} \\ b = \text{1-30 p.m.} \\ c = \text{3-50 p.m.} \end{array}\right\} \times 375.$$

FIG. 5.—Production of resting spores on the submerged hyphae of *Colletotrichum falcatum*, in a hanging-drop × 375.

FIG. 6.—Formation of the spores of *Colletotrichum falcatum* at a spore patch formed in a hanging-drop culture six days old:—

$$\left.\begin{array}{l} a = \text{10-25 a.m.} \\ b = \text{12 noon.} \\ c = \text{5 p.m.} \end{array}\right\} \times 375.$$

A FORMULA FOR THE CALCULATION OF THE AVAILABLE SUGAR.

BY NOEL DEERR.

The earlier formulæ for the calculation of the available sugar in a juice were of the form: Available sugar = sugar — m (glucose), m being a factor varying from unity to two.

Formulæ of this type, which take into account only one of the bodies other than cane sugar, can make no pretence to accuracy, as is readily shown by taking as an example a case, which very rarely occurs in cane sugar practice, but is common in the beet industry, where the glucose is absent; in such a case the formulæ would indicate an extraction of 100% independent of the presence of impurities other than glucose.

Of later formulæ, those most often met with are—

1. Available sugar = 2 (sugar %) — Brix °.

This formula is known as the Stammer formula.

2. Available sugar $= \dfrac{\text{sugar \% × purity.}}{100}$

More sugar than indicated as available by this formula is generally obtained; fifty-one Java factories (*Int. Sug. Jour.*, No. 82) obtained on an average 106·1% of the available sugar as indicated by this formula.

3. Available sugar = sugar % — ·4 (Brix ° — sugar %). This formula is due to Dr. Winter, of Java, and expressed in words indicates that one part of non-sugar prevents 0·4 parts of sugar crystallising. If in this formula for Brix ° we write $\frac{100 \times \text{sugar }\%}{\text{purity}}$ the formula reduces to the form—

$$\text{Available sugar} = \text{sugar }\% \left(1{\cdot}4 - \frac{40}{\text{purity}}\right)$$

Of the sugar indicated as available by this formula fifty-one Java factories recovered on an average (*loc. cit.*) 96·7%. The available sugar in both these formulæ refers to the commercial sugar of average polarization, 97·4%, and not to sugar at 100°.

The formula proposed by the writer takes into account the sugar percentage of the final molasses, and has been obtained under the following argument:—

Let x be the weight of a quantity of masse-cuite which contains s sugar per unit weight of masse-cuite; let there be removed y parts of dry sugar (whether in one or more operations is immaterial), and let the sugar content of the residue (molasses) per unit weight of molasses be m. Then since the weight of dry sugar removed is y, the weight of the residue is $x—y$, and the sugar contained in the residue is $m\ (x—y)$; and since the whole amount of sugar is $s\,x$ the equation— $s\,x = y + m\ (x—y)$ results.

From this equation it follows that $\frac{y}{x} = \frac{s-m}{1-m}$

If in this equation the weight of masse-cuite be put equal to unity, the equation simplifies to the form $y = \frac{s-m}{1-m}$

Now the total amount of sugar present per unit weight of masse-cuite is s; under the conditions of working with sugar percentage in molasses equal to m, the possible recovery from the masse-cuite is indicated above; the result of the calculation can then be put in the following form:

$$\text{Available sugar in the masse-cuite} = \frac{s-m}{s\ (1-m)}$$

Now in modern practice all the sugar originally present in the juice, excepting certain small losses referred to later is recovered in the first masse-cuite, so that s which represents the sugar per unit weight of masse-cuite is also a measure of the sugar present in the

juice; then as m refers to the sugar content of the final exhausted refuse molasses we can write—

$$\text{Available sugar in juice} = \frac{s - m}{s\,(1 - m)}.$$

Now there is very little difference between the figures representing the sugar percentage of a first masse-cuite and the purity of the juice from which it is boiled; if the juice were evaporated down to a dry masse-cuite without any increase in the purity of the juice, the figures would be identical; in practice the process of defecation raises the purity, and the first masse-cuite instead of being dry generally contains about 5% of water; these causes tend to correct each other, so that without sensible error the purity of the juice (referred to unity and not to 100 as usual) may be substituted for s; let this factor be denoted by p; as a fair average constant exhausted saturated molasses can be taken as containing 30% of sugar, so that $m = \cdot 3$.

Then the available sugar being equal to unity, we can write as a general formula—Available sugar in juice $= \dfrac{p - \cdot 3}{p\,(1 - \cdot 3)} = \dfrac{p - \cdot 3.}{\cdot 7\, p}$

This formula can be applied to any stage of the manufacture, the value of m being varied to suit the particular circumstances.

The sugar content of exhausted molasses, although generally about 30%, is by no means a constant, and accordingly for each factory there will be a different factor to be introduced into the general equation dependant on the sugar content of the exhausted molasses.

The equation obtained above can be looked at in a different light; the complete analyses of first masse-cuites made by Geerligs have shown that the molasses proper, *i.e.*, the saturated solution of sugar and impurities not holding in suspension any fine grain, present in a first masse-cuite, contain generally a little over 30% of sugar, and hence may be considered as exhausted molasses, similar in composition to the refuse molasses obtained after a second or third boiling; the sugar crystallised in the first masse-cuite then will represent the available sugar, and the equation—

$$\text{Available sugar} = \frac{\text{crystallised sugar in first masse-cuite}}{\text{total sugar in first masse-cuite}}$$

results; possibly, however, this would give a too low indication dependant on the effect of the addition of lime in the second and subsequent boilings on the solubility of the sugar in the molasses.

The disturbing factors occurring in practical work in connection with this formula are:—

1. Sugar lost in press cake. This is not an absolutely essential loss as the sugar here is recoverable by washing.

2. Sugar lost in entrainment in evaporators, in handling, &c. These losses too are not necessary, and form part of the imperfections of a factory.

3. Sugar lost in inversion. This again is an absolutely unnecessary loss.

In the accompanying diagram curves have been drawn connecting the purity of the juice, the sugar percentage of the final molasses and the available sugar; the figures on the curves represent different percentages of sugar in final molasses; in the vertical line is set out the purity of juice from 75 to 90, and in the horizontal line the available sugar for different instances; as an example of the use of the curves, let the purity of a juice be 85, and the sugar percentage of final molasses 30%; taking the curve marked 30% it is seen that it intersects the horizontal line drawn from the point 85 in the vertical scale at a certain point; the vertical line drawn from this point cuts the horizontal line at the point 92·4, *i.e.*, the available sugar is 92·4% of the total sugar.

Note.—After the writer had finished the above article he noticed that the general formula proposed as representing the available sugar can be transposed to the form

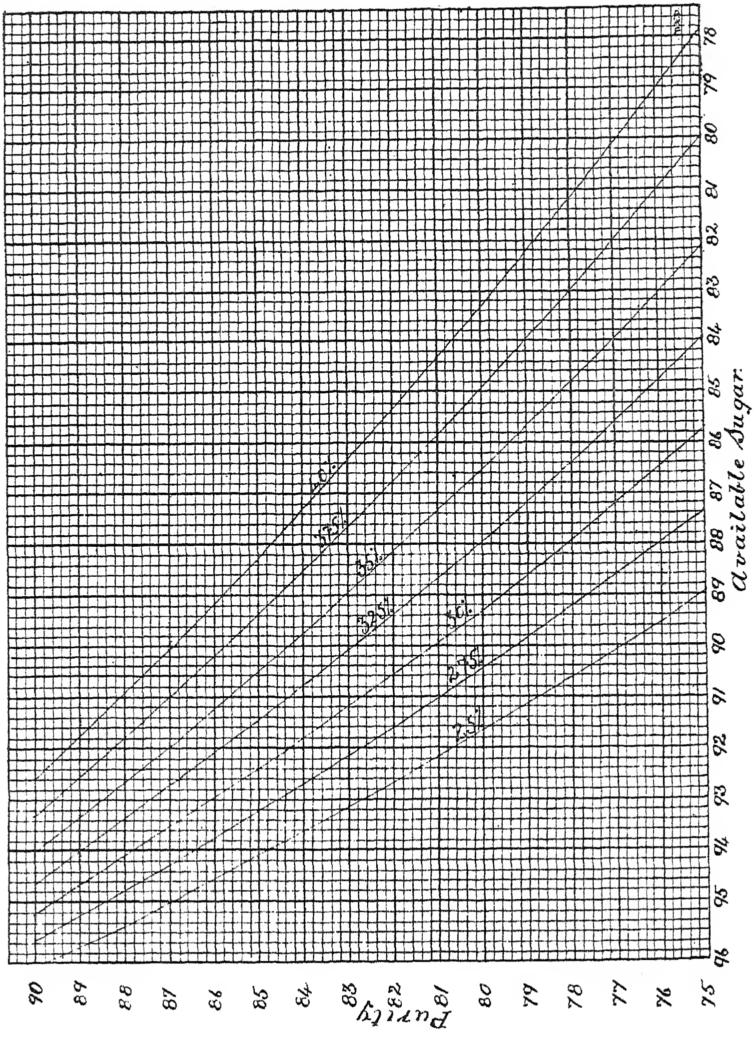
$$\text{Available sugar} = 1{\cdot}43 - \frac{43}{\text{P.}}$$

This is practically identical with the formula due to Dr. Winter; the writer is unaware upon what line of argument Dr. Winter obtained his formula, but the remark (*International Sugar Journal*, No. 16, p. 190) . . . . "that one part of non-sugar prevented the crystallisation of 0·4 parts of sugar" would imply a different line of argument.*

The formula brought forward by the writer is different, too, to others in that it introduces the sugar content of the final molasses a factor that will vary for different factories.

* According to Mr. H. C. Prinsen Geerligs, who has been appealed to on this point, Dr. Winter calculated his figures from results actually obtained in good Java Factories. At the same time Mr. Carp, of Java, calculated the available sugar on exactly the same lines as Mr. Deerr, only with the exception that he assumed a loss in filter-press cakes, &c., of 4 per cent. He then saw that his results were exactly the same as with Dr. Winter's formula, and as this is easily retained, he stuck to it. The assertion that one part of non-sugar prevents 0·4 parts of sugar from crystallizing is only made for convenience sake, and is not to be considered in the light of a scientific statement since all losses in filter-press cakes, and unaccounted for, are equally included in it.—Ed. *I. S. J.*

DIAGRAM TO ILLUSTRATE A FORMULA FOR THE CALCULATION OF THE AVAILABLE SUGAR.



KESSLER'S CONTINUOUS DIFFUSION PROCESS AS COMPARED WITH THE WORK IN THE BATTERY.

By Walter Tiemann.

(Continued from page 200.)

Kessler's process naturally tends to attain a more complete extraction than is possible by the battery. It cannot be disputed that with the latter the slices are arranged on the strainers of the diffusers in a very irregular manner, from which it follows that the extraction must vary much at the different parts of the mass. When comparing this defective mode of operation with the continuous working of Kessler's apparatus it is obvious that the latter, in consequence of the uniform feed of the mass in uniform layers—the formation of nests being impossible—produces a much more regular circulation than the battery, even though attempts have been made to obviate those drawbacks by a special perforation of the strainers of the battery.

The defects of the battery have induced manufacturers to employ *correcting-means* in order to dispense with the unfavourable conditions of the extraction. For instance, the duration of diffusion was made too long or too much water was used, or the temperature was increased too high; in other words, one evil was combatted with another.

Kessler's apparatus renders such procedures impossible: when, for instance, the extraction is to be effected to 0·3%, this quantity of sugar is present in all ejected cane mass, without extending the duration of the diffusion, without excess of water and without super-heating. Thus this explains its great quantitative and qualitative working efficiency; it extracts the raw material just as well if not better than the battery and in less than one-third the time, without affecting the concentration and purity of the juice.

Kessler's process attains all advantages with the least expense and trouble: a result which is only attainable with a continuously working apparatus.

The space occupied is less than half the usual size; the costs of installation are reduced one-half as compared with the battery.

When considering how simple and regular the action of the diffusion is and how the same is easily controlled, the undeniable superiority of the improved process in every respect cannot be doubted.

The manager gives his directions, the percentage of juice to be extracted, the temperature of the water and mash-juice, the number

of revolutions to be made by the conveyor B, which is all that is necessary, because the work is done automatically.

One single workman is sufficient for carrying out this work; he need also only see that the cane mass is fed properly.

It may be remarked that the workmen are no longer troubled with the heat of the ejected slices or bagasse.

Circumstances may occur which necessitate quicker work than usual, even at the risk of losing some sugar; Kessler's process renders it possible to easily accelerate the work without causing as much loss of sugar as when using the battery.

When it is contended that the mass can perhaps not be conveyed from C to F with the normal power, we might point out that the cane mass is conveyed from C to K^1 by its own gravity and the action of the conveyor comes in question only from K^1 to G^1, *i.e.*, for a distance of four meters at the most.

The crushed cane easily slides along the interior of the cylinder, because it is saturated with juice; of course, it would be different if the bagasse were already freed from water, as was the case in the old pillar-presses.

Another question which is generally asked is, why the diffusers with only one receptacle have as yet had no practicable result. A single glance, however, shows us that in the old apparatus for continuous diffusers the sliced mass was not compact enough, a drawback that was only made worse by the mashing devices, which acted against the principle of systematic diffusion.

The reason why the diffusion experiments by means of vacuum have had no satisfactory result is due to the fact that a mistake was made at the outset; for instance, in overheating the slices, feeding the gas and material in opposite directions, mistakes which have annulled the good effects of the vacuum.

The characteristic feature of Kessler's process consists in the fact that in consequence of a suitable preparatory operation, *i.e.*, the mechanical mashing and heating, the uniform arrangement of the slices into a compact mass, and the complete and permanent off-suction of the air, all requirements for a rational diffusion process generally, and especially for a continuous one, are properly fulfilled.

As being of special interest for machine manufacturers, we will further mention that the construction of the feeding devices B and C has recently been better adapted to the treatment the sugar cane requires.

In the *Journal d. Fabr. de Sucre*," 1896, No 20, appears the following comparison on the Ewa plantation of Pohlmann:—

	100 Milling Juice.		100 Diffusion Juice.
Brx.	19·2	....	21·2
Pol.	16·5	....	17·4
Purity	86·0	....	82·0
Gluc.	0·93	....	1·75
Output for 100 sugar treated and calculated as 100% sugar	83·135	....	76·351
Factory loss	11·888	....	4·843
Sugar in molasses	4·977	....	18·806
	100·000	....	100·000

The cane treated with diffusion was essentially inferior, that is to say the juice had a purity of 82 against 86 of the milled cane.

If the same cane of 82 purity had been milled there would not have passed in round figures five parts of pure sugar into the molasses but seven parts of pure sugar into the molasses, there have consequently passed yet about $\frac{18\cdot8}{11\cdot8}$ parts of pure sugar too much, through the faulty diffusion process, into the molasses, instead of increasing by the same figure the refining value of pure sugar from 76·35 to 88·15.

In order to compare the output of the milling process with a proper diffusion process and the same quality of cane from the cane of 86 purity there ought to have been preserved in round figures 90% of the sugar passed into the juice.

According to the above statements the Kessler process yields:—

ca. 40% juice of cane through the crushers
,, 45% ,, ,, as diffusion juice.

The latter should, however, according to the above explanations, be preserved, at least as far as purity is concerned, in the same proportion as the milling juice, so that the loss of sugar in the manufacture (through using the press-water from the megass-mill, which water has also exhausted the sugar contained in the scums) should not reach up to 5% of the total amount of sugar in the juice, and the loss of sugar in the molasses should also remain below 5% of the total amount of sugar, so that therefore certainly more than 90% of the sugar contained in the cane should be extracted.

This result can only be obtained by using the crushing-machine in conjunction with the relatively cheap diffusion apparatus which further allows of dispensing with one mill when there are three. The evaporation apparatus and the boiler-house, need not be enlarged if the amount of cane to be worked remains the same; likewise the purification of the juice is simplified.

In this way the diffusion process must raise the cane sugar industry to the same yield and refining value of the raw sugar as will again make it equal to its rival, the beet sugar industry.

DEFECTS OF BATTERY.	ADVANTAGES OF KESSLER'S PROCESS.
1 hl contains only 43 kilos. of material and 70 liters of water.	70 kilos. of material and 35 liters of water per hl.
Waste spaces.	No waste spaces.
Irregular spaces and passages.	Small uniform spaces. No passages.
Working interruptions and stoppages in the battery owing to the strainer at the bottom.	Free and regular circulation owing to the omission of strainer bottoms.
Stopping up of holes in the strainer bottom. Resistance against good circulation. At least 10-16 filtering surfaces.	Only one filtering surface, along which the cane mass moves.
The holes are liable to get stopped up during working.	Easy and quick remedy in the event of temporary obstruction of the holes.
The gases prevent the circulation.	The gases assist the circulation by passing with the along liquid.
The circulation suffers through the change in the structure of the slices in consequence of superheating. The gases and the air contained in and between the cells retard the osmotic effect and consequently the extraction.	Normal circulation the cane masses maintain their normal structure in consequence of the automatic mashing process. The production of a vacuum facilitates the osmotic action and consequently the extraction.
Mashing with juice containing air.	Mashing with juice without air.
Long duration of the diffusion process.	The duration of the diffusion process is reduced more than only one-third.
Waste spaces and passages. Irregular circulation.	No waste spaces or passages. Regular or uniform intermediate spaces ensure a good circulation.
Defective filling, because the mass is more compact in the middle than at the edges.	Mechanical filling, consequently homogeneous mass.
Irregular circulation decreases the density of the juice. Irregular extraction.	Regular circulation thick juice, uniform extraction for all crushed cane.
70 kilos. of slices.	70 kilos. of cane mass.
43 ,, ,, water.	35 ,, ,, water.
	Acceleration of the circulation.
Less concentrated juice, owing to larger quantity of diffusing liquid.	Stronger concentration of the juice on account of less quantity of diffusing liquid.

The longer the diffusing period, the more dissolved non-saccharine substances in the juice.	Shortened diffusing period, hence less non-saccharine substances in the juice.
Change of the unmoving mass by superheating a layer.	The cane masses maintain their normal shape owing to the mechanical mashing and heating.
The extraction of the last particles of sugar lasts long; the slightly soluble foreign substances mix with diffusing liquid.	The extraction of the last particles of sugar takes place more quickly and need not be carried on so far. The diffusing juice is purer.
Irregular extraction.	Uniform complete extraction.
Correcting-means for overcoming the detrimental consequence of the irregular extraction, which resulted from other drawbacks.	
The heat of the outgoing slices is troublesome to the workmen.	The workmen do not come in contact with the hot slices.
By forcing the work, comparatively much sugar is lost.	Possibility of forcing the work without great losses of sugar.

HAWAII.

From an esteemed correspondent in the Hawaiian Islands we learn some particulars about the sugar industry out there. The year 1902 appears to have been the most serious one which the industry in those islands has passed through, consequent on the awful drought which was encountered in the previous year; the price obtained for the sugar was extremely low, being about $2\frac{1}{4}$ cents per lb., and in at least three districts of Hawaii the crops were about 50% short of the average. Needless to say, the planters suffered a heavy financial loss, which in some cases will take a few years to recover from.

The total output of the Islands was 355,611 short tons, being 14,424 tons less than in the preceding year. 234,316 tons were produced by plantations using irrigation exclusively, and 121,295 tons by those relying on natural resources.

All the mills have been for some time grinding the 1903 crop. Where irrigation is used, the crop is normal. In the island Hawaii, where they depend on rainfall the prospects for the large crops are good, and given the continuation of favourable conditions and good prices, it is expected that the losses of last year will be made up, and leave something in hand.

Labour conditions after a good deal of shortage and advance in wages and inefficiency in work done have again become normal. Labour supplies are coming in every month, principally Japanese, though a few hundred Coreans have been lately introduced by the Sugar Planters' Association, which manages and looks after the labour supply.

THE SUGAR CANE IN EGYPT.

By Walter Tiemann,

Member of the Society of German Sugar Technists and of the Assoc. des Chemistes de Sucreries et Distilleries, Paris.

(Continued from page 176.)

Manuring of the Sugar Cane.—*Continued.*

Nitrogen, phosphoric acid, and potash are not in general available in sufficiently efficacious quantities in the soil as to allow the cane to achieve the best results, and every prudent planter will supplement them by the purchase of artificial manures in definite amounts. In the many forms in which these latter are placed on the market, the writer considers the following the most suitable and profitable for the cultivation of cane on Egyptian soils:—

For Nitrogen: Saltpetre.
For Phosphoric Acid: Thomas Slag.
For Potash: Potassium Sulphate.

The nitrogen forms the motive power of the ground, and effects a powerful formation of stem and leaf organism, and thereby a better assimilation of the remaining substances. The atmosphere in the tropics yields under favourable conditions more nitrogen to the ground than in colder regions. Its partial self-formation by means of the nitrogen-absorbing leguminose was mentioned when describing green manures. Yet this does not suffice; and for supplementing it saltpetre is more suitable than ammonium sulphate, owing to its direct action. With the existing conditions of irrigation it is likewise easier to work with the former without encountering any loss of available sulphuric acid. Experiments have also proved that saltpetre yields much better and more profitable crop results than ammonium nitrate, having regard to the cost of this latter manure. The ammonia must first change into nitric acid, and then part of it is easily lost through the watering. In Java, for example, only ammonium sulphate is employed, because, owing to the subsequent heavy rains, the saltpetre would all be washed away. Thus the conditions are often different. In Egypt one applies the saltpetre direct in small quantities about two days after watering, when the soil is yet wet, and one, two, or three months after the planting, never later. In the interval of a fortnight till the next watering the plants have time to absorb fully all the saltpetre, and are thereby freshly invigorated for assimilating the remaining nutriments. It is merely a question of strengthening and supporting the cane in its early development as regards the formation of absorbing organs, so that by these and the absorbed nitrogen the further building up of cells and a more luxurious plant-growth can take place. Again, organic manures, such as blood

mixture, meat meal, bone dust, as well as the pressed remains of oleaginous fruits may be employed, owing to their nitrogenous nature, but are mostly unavailable in sufficient quantities, or not cheap enough for great cultures.

Phosphoric acid is almost invariably a necessary supplement to the requisite substances for the favourable development of vegetation in Egypt. The employment of nitrogen alone in the case of the sugar cane brings about an apparently luxurious vegetation, but a weak, unresisting cane stem, which is laid low by the first storm, and is in general of little value for manufacturing purposes. On the other hand, if the supply of nitrogen is combined with that of phosphoric acid, then one obtains a powerful, vigorous, resisting cane stem, and a ripe sugar cane for the factory. By the action of the phosphoric acid the degree of ripeness and the sugar content are specially favourably influenced. How necessary it is to constantly replenish the soil for the phosphoric acid drained from it is shown by the following figures:—

During one harvest there are absorbed from each hectar of ground—

Crop.	Kilos. Phosphoric Acid.
Wheat	34·5 to 50·5
Clover	36·4 ,, 52·0
Cotton	50·3 ,, 75·3
Sugar Cane (stems)	71·6 ,, 120·0
,, ,, (leaves)	61·6 ,, 103·2

The most suitable of the artificial phosphate manures coming under our consideration are superphosphate bone dust and Thomas slag. To estimate their special value for cane culture, these two may be shortly described in their properties. The superphosphates are obtained from very insoluble raw phosphates, the residues of fowl droppings, mineral apatite, and phosphorite, bone dust, and animal charcoal, by means of solution with acids, so as to transform the phosphoric acid of these substances into a form soluble in water. They then contain 11 to 20 per cent. phosphoric acid, and their value lies in their solubility in water, and corresponding quicker absorbtion and action. The double phosphates are reduced to a composition of 45 per cent. soluble phosphoric acid. From which raw material the superphosphates are obtained does not matter, as its value depends exclusively on its content in soluble phosphoric acid. The degree of fineness is thereby of importance. It should, where possible, be in a fine powder, dry, and easily capable of distribution. The Thomas phosphate is a by-product in the manufacture of phosphate-free steel. According to the Thomas process, the iron ore is mixed with lime and then melted under the influence of a powerful forced draught of air, whereby the phosphorus present in the ore is oxidised and converted into phosphoric acid. The result is a fine quality steel, free

from phosphorus, and the phosphoric acid forms with the lime a slag called Thomas phosphate. The composition of this important substance is somewhat as follows:—

11 to 23% Phosphoric Acid, soluble in citrates.
38 ,, 60% Lime.
7·5 ,, 25% Iron Oxide.
2·5 ,, 13% Silicate.

The phosphoric acid is mostly combined with lime, nevertheless some free lime and gypsum are also present therein. Since the time that cheap Thomas phosphates have been known and manufactured in technically perfect form their use has of course increased very considerably. The reason why Thomas phosphate is to be preferred for cane culture appears from the following:—

In Egypt the sugar cane exists for a period of ten or eleven months, and is planted for two successive years. In the second year the cane springs up anew from the first year roots. The ground is not then ploughed up, and manure cannot be mixed in so well. The action of the superphosphate is of but brief duration, and when in the ground is partly transformed into a condition in which it has lost its solubility in water. The reason of this is the chemical reaction between the phosphoric acid and the lime, magnesia, aluminium, and iron present in the soil, thereby forming insoluble combinations. For cultures of short duration superphosphate is to be preferred as a manuring medium. For cotton, in particular, it gives good results. For the sugar cane, however, its place is better taken by Thomas slag, not only on account of its cheapness, but also because of its collective properties. Its value depends on its content in phosphoric acid soluble in citrate and its degree of fineness. Empirically every finer pulverisation of a manuring medium, having constituents soluble in water, has a greater effect, because it is thereby the better enabled to mix with the soil and ensure copious contact with the absorbing plant roots. As Thomas phosphate has an action of several years' duration, it is specially suitable as a preliminary manure, and one the writer has employed for his cane cultures. When one has sufficiently dressed the first year plants with this phosphate, the phosphoric acid which was not used up in the first year by say two-thirds is available for the second year as stock in hand. It will then only be necessary in this year to aid the quantitative result by a top dressing with saltpetre. The Thomas phosphate will be distributed by the last ploughing in the preparation of the fields for first year cane.

Potash forms one of the most important mineral matters which are absorbed by the cane, and, in spite of that, its application has been hitherto a little solved question as regards its bearing on yields. The alluvial soil in Upper Egypt is not exactly poor in potash, inasmuch as it contains about 0·5 to 1·5% K_2O. As compared with this, the huge annual amount of 175 kgr. K_2O per hectar is used up during

each annual harvest, so that sooner or later a scarcity of this food will ensue in the different cane growing districts. As potash does not act by itself, but only in combination with other substances, it is mostly difficult to obtain information as to its action, especially in the last few years, where unfavourable weather conditions have prevailed, so that the cane did not fully mature. The sugar content depends in the first place on the climate. In the case of those portions of land treated with potash, increased quantities of the same mineral were found on analysis in the subsequent cane, a proof that the potash is assimilable by the cane. It is to be noticed in every case that when fully manuring with nitrogen and phosphoric acid together, the corresponding application of potash has a particularly favourable result on the sugar content. In the case of cotton cultivation in the Delta, where the ground is of similar constitution to that in Upper Egypt, manuring with phosphate of potassium has had pronounced results on the quality and the quantity of the harvest. Sooner or later there will be a potash famine in Egypt, and it is therefore important to bear that in mind, so as to protect this commodity from complete exhaustion. As potash manures for cane, one must avoid chlorate products; sulphate of potash is the best form to employ where a substitute is required. In the other cane growing lands—for example, Barbados—good results have followed a manuring with potash, and Professor d'Albuquerque considers the presence of potash useful to complete the manuring.

He recommends the following:—

	For 1st year Cane. Per acre. Lbs.	For 2nd year Cane. Per acre. Lbs.
Nitrogen—		
Two-thirds $(NH_4)_2$ SO_4 / One-third $NaNO_3$	60	80
Phosphoric Acid—		
For soil rich in lime, superphosphate / ,, poor ,, Thomas slag	40–45	30
Potash	40	30

The amounts to be applied of these three chief nutriments, and in what proportion so as to obtain the best results, depend in Egypt as well on the local conditions. Here even the ground varies. One has to distinguish between black and yellow soils (*arde soda* and *arde safra*), and naturally also the gradations of the same. The climate likewise varies in the long stretches of land from Cairo to Assiut. The preliminary crops and their rotation require as well to be considered. All this will be carefully weighed by a skilful agriculturist according to his experience when discussing the question of manuring, without here going into details.

From experiments undertaken by the writer, and his observations during the last five years, he can recommend in general the following

manures for Egypt. In the first place nitrogen in combination with phosphoric acid has to be considered. The practical working of potash requires further elucidation than has hitherto been the case. The potash is possibly not everywhere of equal necessity. The amounts would be as follow:—

A.—For First Year Cane—	Per Feddan.* (4,200 sq. metres) Kgr.	or	Per Acre. Lbs.
Saltpetre	75	....	185
Thomas Phosphate	200	....	500
Finally, Sulphate of Potash	50	....	125
B.—For Second Year Cane—			
Saltpetre	75-100	....	185-250

*1 Feddan = 1·126 Acres. 1 Kilo = 2·2 lbs.

The Thomas phosphate and potash must be distributed over the surface of the fields on the occasion of the final ploughing, and in calm weather. Finally we mix these manures with an equal volume of dry earth for better spreading.

Saltpetre is given in two applications as a top dressing, 1 and 1½ and 2½ to 3 months after planting. In the usual case of planting in February, the end of March and the middle of May would be the periods. But, for an early planting, the first dose can be given at the end of January or beginning of February. The saltpetre should be distributed immediately after a watering of the plant rows, within a day or two of the irrigation water having settled down on the surface. It should be mixed with an equal volume of dry sandy soil. In this connection it must be observed that the potash should not be thrown on the young leaves, but laid on with the hand.

The special expenses come out as follows:—

Approximate Cost of Artificial Manures in Egypt.

		Piastres.
Saltpetre	per 1000 kilos.	975
Thomas phosphate	,, ,,	320
Sulphate of Potash	,, ,,	1000

1 Piastre = 2½d.

From this we find the cost per feddan (1·126 acres)—

A.—For First Year Cane—	Piastres.
Saltpetre	75
Thomas Phosphate	64
Potash Manuring	50
Field Transport Expenses	10
Strewing	1
Total	200

B.—For Second Year Cane—

Saltpetre	100

The revenue can easily be calculated. With the above manuring, it is a matter of course to expect under normal conditions of tillage

For First Year Cane an increase of 150 cantars of cane per feddan; for Second Year Cane an increase of 200 cantars per feddan	as compared with unmanured canes.

Egyptian cane obtains an average price of $2\frac{3}{4}$ piastres per cantar. For this we expend in manuring—

		Piastres.
For First Year Cane..	per feddan	200
For Second Year Cane	,,	100
Total		300

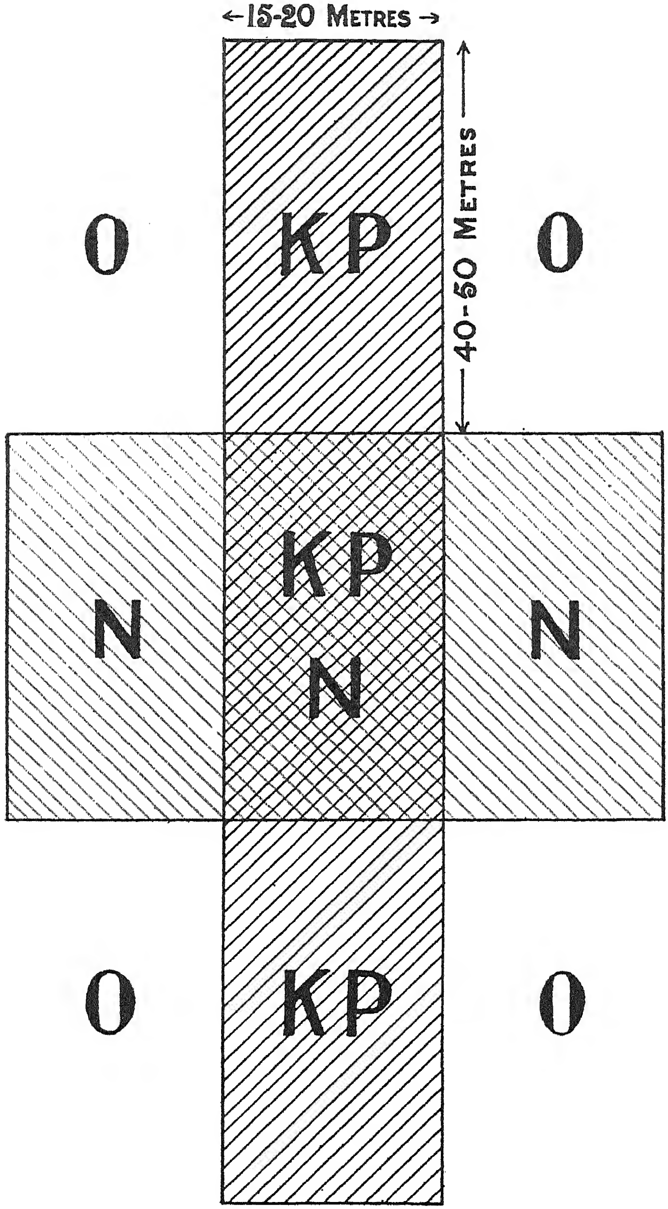
against which we can place the income from the increased yield of

150 Cantars First Year Cane	412·5
200 Cantars Second Year Cane	550
Total	962·5

Thus the outlay in artificial manures repays one at the end of two years' harvests by 300 per cent. or more. The above is no optimistic calculation, but one to be looked for and obtained in every case under normal conditions.

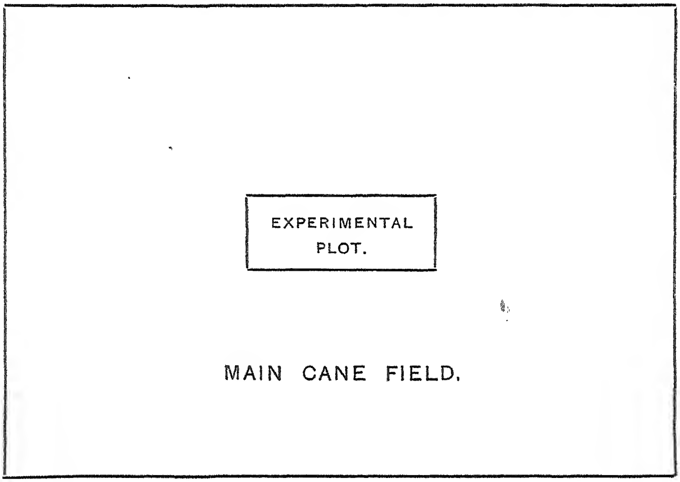
The Arrangement of Field Experiments.

The foregoing methods of manuring must not, as above mentioned, pass for the only ones, but, on the contrary, the planter must employ the different manuring mediums according to his own practical experience. The question often arises, for example, whether a liming is in place or not for heavy soil; also how far the existing natural sources of manure, "compost," and such like, can be counted on. In order to settle such a question for a particular locality, the practical agriculturist will start an experiment field, preferably in such a way that he can carry out manurial experiments on a measured piece of ground in the midst of a large area of growing cane. He can then observe whether the manured portion differs from the surrounding fields. To ensure drawing correct conclusions from such experiments, they must be under continuous observation and control during the whole period of vegetation up to the harvest. One can then ascertain, for instance, whether the leaf formation is stronger, their colour darker and more intensive, the canes stronger and taller, than the adjacent unmanured plants, and finally, at harvest time, compare the respective degrees of ripeness, weight, and sucrose content. The



PLAN OF EXPERIMENTAL FIELD ACCORDING TO DR. WEITZ' SYSTEM.

experimental areas are best arranged in oblong form, as in the accompanying plan, the size depending on the area of the main fields. For any such single experiment one might employ the full manuring as described in the last chapter.



As a demonstrative manurial experiment for ascertaining the value of artificial manures on the different soils, the practical system adopted by Dr. Weitz, secretary to the Delegation of the United Association of Saltpetre Manufacturers in Berlin is here given. This simple and lucid experimentation is of valuable assistance to an agriculturist for solving the question of artificial manures without any preliminary theoretical study. It consists, as the accompanying sketch shows, in the preparation in the midst of the fields of two transverse areas, pegged out by means of twelve posts. The writer considers small areas, such as answer for European beet experiments, inconclusive and misleading for cane. Their size should be at least from 600 to 1,000 square metres.

The long portion shaded black in the sketch receives a dressing of potassium phosphate before the final ploughing; the other, shaded red, one of saltpetre after the planting. Hence we have here five parcels of ground as shown in the sketch, where KP stands for phosphate of potash manure, and N for saltpetre. The surrounding fields O show the unmanured area.

If at harvest time the quantities can be weighed it is decidedly advantageous, yet not absolutely necessary, as long before the harvest the state of the plants in the different plots shows the planter

conclusively the effect of the particular manures and, aided by his constant observations, yields him a sufficient answer to the question what manures his ground most needs, potash, phosphate, saltpetre, or all three. It is advisable to duplicate these experiments, one on limed and the other on unlimed soil. Then one can simultaneously solve the question of liming for particular soils. The outward appearance is sometimes deceptive, yet if possessing good powers of observation, one can learn much, *e.g.*, one will discover that on applying nitrogen alone, the cane has a better outward appearance than if unmanured while being inferior in ripeness and sucrose content; whereas with simultaneous manuring with phosphate of potash the middle parcel develops a fully ripe cane such as the factories long for. Nitrogen alone is most unsuitable, save for second year canes.

If, thirdly, it be desired to ascertain accurately the nutriment and manure requirements of a soil by definite experiment, then it is best in general to work on the following plan.

1. Unmanured.
2. With Nitrogen.
3. ,, ,, and Phosphate.
4. ,, ,, ,, Potash.
5. ,, Potash and Phosphate.
6. ,, Nitrogen and Potash and Phosphate.

This arrangement of the experiments is best carried out, like the previous ones, in the midst of a large area of cane, so that the experimental cane is surrounded by other canes. The experimental plots are divided from the rest by a narrow path. The manures should be placed in these rows in equal quantities. The actually required amounts of each medium can be easily calculated later on. These are matters which cannot be settled in one year. As to the size of the plots, the writer considers that for Egyptian requirements about 1,000 square meters (20 by 50) in an oblong form would be the most suitable. The object of each experiment field is to obtain the largest possible return, and place it to the credit of this or that manure as the case may be. To that end, it requires careful observation during the whole period of vegetation, also, before and after planting, a complete and uniform tillage of the soil. And especially must one ensure that the characteristics of the soil are uniform throughout. One can choose with advantage for this object a uniform black, or a medium soil. The amount of the crop must be carefully ascertained by weighing, and after the harvest chemical analysis follows. If the experiments are to yield conclusive proofs, then these [illegible]sions should be rigidly followed, and that in the case of the majority of the plots is easier said than done. For analysis the outer portions of each plot should be avoided, as they are eventually influenced by the manuring of the adjacent plots.

The accurate and difficult taking of average tests is of weighty importance. To that end, the spreading of the manure should be done as carefully as possible, and only in calm weather. These tasks must all be carried out under personal supervision, unless one possesses trained and trustworthy subordinates, for it is often a matter of indifference to such people as the natives as to what they weigh, so long as it is quickly done. Such observations one will soon have occasion to make, and if one does not know the special conditions of the local soil, it is better to carry out a few exact and simple tests than many and (as is inevitable during the harvest) possibly inaccurate ones.

(To be continued.)

APPLIED ECONOMICS. PRICE DIAGRAM.

WALLWYN POYER B. SHEPHEARD, M.A.

The diagram on next page illustrates a curious and hitherto, as far as the author can discover, unobserved law of price adjustment.

Briefly stated, any price tends to vary from the normal or standard price selected for comparison, in direct ratio with the variation of demand, and in reciprocal ratio with the variation of supply.

In the diagram the normal or standard price is taken as £1; if any other normal be selected it must be reduced to its decimal equivalent and multiplied by the prices in the diagram.

As is pointed out in the note on the diagram, the upward and downward tendencies may be adjusted to a mean price by adding to or subtracting from the prices resulting from the variation of supply, a tenth of each such price for each one-tenth increase or diminution respectively in the demand.

For example: Let the demand (D) be deemed to have increased two-tenths, and the supply (S) to have increased five-tenths, then the originating ratio will become $\frac{D}{S} = \frac{£1{\cdot}2}{1{\cdot}5} = £{\cdot}8$. But when $S = 1{\cdot}5$ the price is $\frac{£1}{1{\cdot}5} = £{\cdot}667$. Add $\frac{2}{10}$ths $= £{\cdot}667 + £{\cdot}133 = £{\cdot}8$. Or, let the demand be deemed to have decreased $\frac{2}{10}$ths, and the supply increased $\frac{5}{10}$ths; then the originating ratio will become $\frac{D}{S} = \frac{£{\cdot}8}{1{\cdot}5} = £{\cdot}534$.

But when $S = 1{\cdot}5$ the price is $\frac{£1}{1{\cdot}5} = £{\cdot}667$; subtract $\frac{2}{10}$ths $£{\cdot}667 - £{\cdot}133 = £{\cdot}534$.

Illustration.

A merchant or broker being desirous of estimating the probable effect on the price (say of sugar) in consequence of an increase in the supply of (say) four-tenths above that of some antecedent period, let

him first note the average price for that period, (say) 16s. per cwt. He expresses that as £·8, and treats it as the normal. On inspecting the diagram he finds that for an increase of supply of four-tenths the normal of £1 on the diagram has become £·714. He multiplies this by the new normal of £·8 and finds that the price becomes £·571 = 11s. 5d. But he infers that this fall in price will probably increase the demand by (say) one-tenth. He therefore adds one-tenth: £·571 + £·057 = £·628 or 12s. 7d., and this 12s. 7d. he would conclude to be the variation from the normal of 16s. in the antecedent period under comparison.

It may be objected that in actual business no such method is or can be adopted. We reply that every price is made throughout the whole period of a market day by each buyer and seller estimating in his own mind the prospects then existent of a better or less inquiry, and of a greater or less supply.

The purport of this diagram is to induce buyer and seller to reduce their mental calculations or estimates to a specific estimate of the consequent respective variations in supply and demand, and then make their final conclusions as to price. Without recourse to the diagram the price could be arrived at independently, thus:—

Let demand be estimated at an increase of one-tenth, and supply of four-tenths.

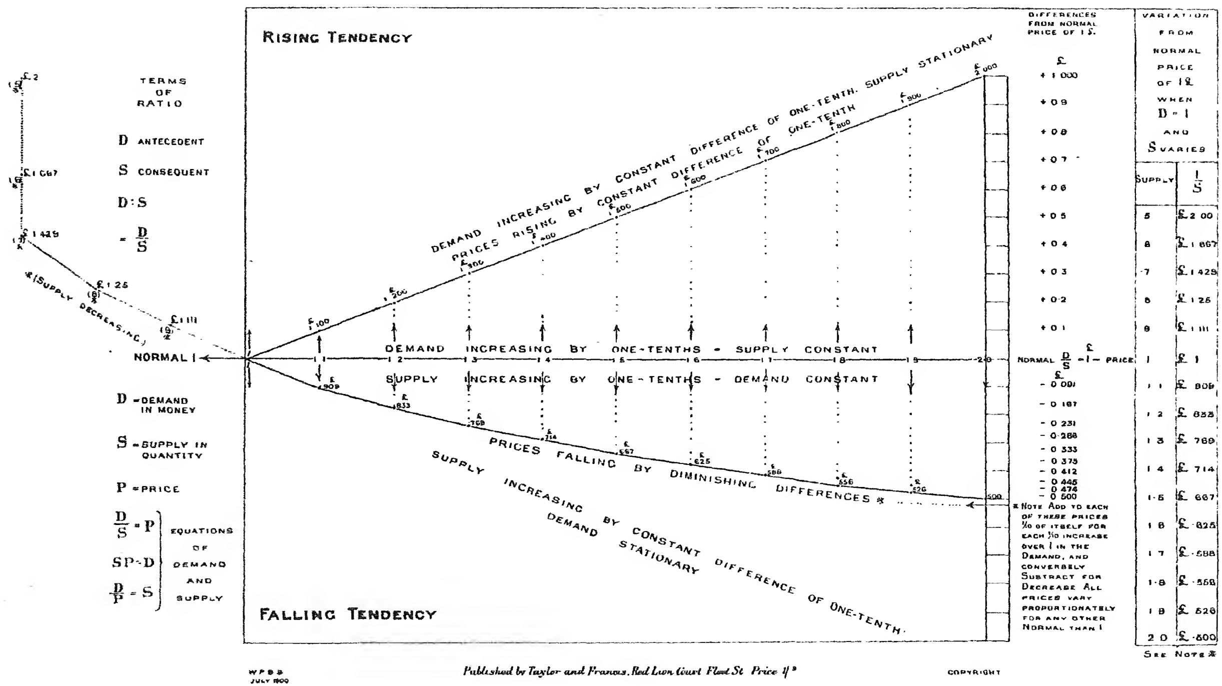
$$\text{Then } \frac{D}{S} = \frac{\text{Demand}}{\text{Supply}} = \text{say } \frac{£\cdot 88}{1\cdot 400} = \text{price, } £\cdot 628 \text{ or } 12s.\ 7d.$$

Conversely for decrease: Let demand be estimated at a decrease of one-tenth, and supply of four-tenths.

$$\text{Then } \frac{D}{S} = \frac{\text{Demand}}{\text{Supply}} = \frac{£\cdot 8 - £\cdot 08}{1 - \cdot 4} = \frac{£\cdot 72}{\cdot 6} = £1\cdot 2 = 24s.$$

The author does not ignore such incidents as pressure to realize from diminishing margins of value, or other causes, and apprehension of new taxes, and possibilities of an increase or diminution of bounties, but only desires that brokers and merchants should give effect to all such incidents as operate on their minds by an estimate of their influence in a numerical form on supply and demand; to estimate that the demand and the supply has increased or diminished by one or more tenths requires no greater effort in settling a price than in arriving at a price by balancing, in an indefinite way, haphazard notions as to the variations of supply and demand. A leading merchant once informed the author that a seller should always fix his own price, but a buyer should always employ a broker or agent. The author ventures to think that if all buyers and sellers would adjust their prices in a more definite way, as indicated in this diagram, a greater stability of price would result, and panic influences be less and less elements in the adjustment.

TENDENCY OF RISE AND FALL IN MARKET PRICES CORRESPONDING TO VARIATIONS IN THE RATIO OF DEMAND AND SUPPLY.



NOTE.—The above diagram has been considerably reduced in scale from the published diagram. The author has expressly allowed the reproduction in this journal. Copies of the published diagram can be sent from the office of this journal on receipt of 1s. 2d.

As owing to the reduction in the reproduction of the diagram the figures are indistinct we reprint the tabular figures:—

VARIATION FROM NORMAL PRICE OF 1£ WHEN D. = 1 AND S. VARIES.

Supply.	$\frac{I}{S}$	Supply.	$\frac{I}{S}$	Supply.	$\frac{I}{S}$
·5 ..	£2·00	1·1 ..	£ ·909	1·6 ..	£ ·625
·6 ..	£1·667	1·2 ..	£ ·833	1·7 ..	£ ·588
·7 ..	£1·429	1·3 ..	£ ·769	1·8 ..	£ ·556
·8 ..	£1·25	1·4 ..	£ ·714	1·9 .	£ ·526
·9 ..	£1·111	1·5 ..	£ ·667	2·0 ..	£ ·500
1 ..	£1				

NOTE.—Add to each of these prices 1/10th of itself for each 1/10th increase over 1 in the Demand; and conversely, Subtract for Decrease. All prices vary proportionately for any other Normal than 1.

SUGAR CANE EXPERIMENTS AT BRITISH GUIANA.

BY ALBERT HOWARD.

(Continued from page 185.)

PLANTATION RESULTS (1901-02).

The return of the results obtained on plantations during the crop of 1901-02 in British Guiana, is of such interest and value that it is reproduced in full.

BOARD OF AGRICULTURE.

SUGAR CANE EXPERIMENTS.

The following tables have been prepared from the data submitted by plantations in British Guiana which are taking part in co-operative experiments with varieties of sugar cane.

They give in the case of each variety reported upon the means of the data supplied in cases where the area reaped of a variety was *not less than one acre*, the figures given in the record of the experiment showing the highest return of commercial sugar, and those given in

the record of the lowest return. Where canes of a variety have been reaped during the crop-year, 1901-1902, at the Board's Experimental Fields, at the Botanic Gardens, their average records are given for comparison with the results recorded by the estates as obtained on the manufacturing scale.

It is much to be regretted that the plantations belonging to one firm on whose estates experiments with varieties of sugar cane have been carried on, on perhaps more extensive scales than elsewhere in the colony, have not seen their way to furnish the Sugar Cane Experiments Committee with their results.

The Sugar Cane Experiments Committee being impressed with the danger which underlies hasty deductions from agricultural experiments conducted over the crops of only one year even when carried out on the relatively large scale these have been, refrain from making any observations on the results, and from drawing any deductions therefrom. The data are placed on record for comparison with those which may be obtained in later series of experiments.

The values of the data vary greatly, the results recorded where the experiments have extended over large areas and on several plantations being generally more reliable than where, as in the cases of Nos. 625 and the Sealy variety, the areas were small and the number of experiments reported were few.

The mean yields in tons of commercial sugar per acre reported, are as follows:—

	Tons per acre.		Tons per acre.
1. No. 625	2·95	6. White Transparent	2·03
2. Sealy	2·49	7. No. 74	2·03
3. No. 95	2·24	8. No. 147 B	1·99
4. Bourbon	2·18	9. No. 109	1·91
5. No. 145	2·17	10. No. 78	1·39

It must be borne in mind that in the cases of the majority of the results recorded the varieties other than the Bourbon have been grown on land on which the latter cane does not flourish, while the Bourbon returns are, as a rule, from land of fair average quality.

The Sugar Cane Experiments Committee desires to express its thanks to those proprietors, attorneys and managers, who have been good enough to place their experimental results at the disposal of the Committee, for what it is hoped may prove ultimately for the benefit of the sugar industry of this Colony.

J. B. Harrison,

Deputy Chairman, Board of Agriculture.

Name or Number of Canes......	No. 625.				Sealy.			No. 95.			
	Plantations.			Botanic Gardens.	Plantations.						Botanic Gardens.
	Means.	Highest Yield.	Lowest Yield.	Means.	Means.	Highest Yield.	Lowest Yield.	Means.	Highest Yield.	Lowest Yield.	Means.
Descripiton of cane	Plants	Plants	Plants	Ratoons	Plants	Plants	Plants	Plants and Ratoons	Plants	Ratoons	Ratoons
Age when cut (in months)........	12	12	12	11	12 to 13	13	12	8 to 13	13	12	11
Acres reaped	1 to 7	7	1	..	2 to 3	2	3	1 to 28	7	1	..
Average yield of canes in punts or tons per acre	46·8	40·7	36·4	52·1	35·7	41·2	33	32·2	49·8	25	19·9
Milling quality	Bad to fair	Bad	Fair	Fair	Fair to good	Good	Fair	Very bad to good	Poor	Good	Good
Normal Juice.											
Specific gravity, $\frac{30\cdot0}{15\cdot5}$............	1·0572	1·058	1·0588	1·070	1·0620	1·065	1·0571	1·0638	1·0579	1·066	1·081
Degrees Balling or Brix	14·9	14·4	15·1	17·9	15·6	16·4	14·7	16·4	14·9	16·5	20·4
Saccharose in pounds per gallon..	1·193	1·220	1·189	1·536	1·394	1·52	1·258	1·463	1·296	1·510	1·968
Glucose in pounds per gallon	·151	..	·157	·312	·112	·131	·111	·102	·100	·146	·035
Quotient of purity	75·7	80	74·3	80·1	82·1	79·8	81	83·9	82·2	86	89·2
Quotient of Non-sugars	14·7	7·8	15·8	3·4	11·3	8·7	11·9	10·3	11·5	5·6	9·1
Gallons of juice per acre	6,564	7,231	5,405	8,304	4,910	5,940	4,598	4,249	6,912	1,969	2,915
Tons of Saccharose in the juice per acre......................	3·50	3·91	2·86	5·65	2·90	3·60	2·58	2·72	3·99	1·23	2·56
Tons of commercial sugar obtained per acre......................	2·95	3·34	2·41	..	2·49	2·95	1·91	2·24	3·35	·95	..
Quality of megass...............	Very poor to good	Very poor	Good		Bad to good	Good	Bad	Very bad to Fair	Bad	Very bad	
Total number of Experiments reported	4	..	..	..	4	..	..	12	..	..	..
Acres reaped Experimentally	11	..	..	..	9	..	..	80	..	..	..

Name or Number of Canes..	Bourbon.				No. 145.				White Transparent.			
	Plantations.			Botanic Gardens	Plantations.			Botanic Gardens	Plantations.			Botanic Gardens
	Means.	Highest Yield.	Lowest Yield.	Means.	Means.	Highest Yield.	Lowest Yield.	Means.	Means.	Highest Yield.	Lowest Yield.	Means.
Description of canes	Plants and Ratoons	Ratoons	Plants	Ratoons	Plants and Ratoons	Plants	Plants	Ratoons	Plants and Ratoons	Plants	Ratoons	None reaped.
Age when cut (in months) ..	12 to 16	14	12	15	11 to 13	12	13	15	11 to 15	13	11	
Acres reaped	13 to 434	21	208	3	1 to 11	6	9	..	1 to 101	101	1	
Average yield of canes in punts or tons per acre	30·4	46·7	25·3	20·6	35·1	55·2	27·9	40·8	31·3	44·2	19·9	
Milling quality	Good	Good	Good	Good	Bad to good	Bad	Hard	Fair	Fair to good	Fair	Fair	
Normal Juice.												
Specific gravity, $\frac{30\cdot0}{15\cdot6}$	1·0642	1·060	1·070	1·0778	1·0617	1·0563	1·056	1·0775	1·0609	1·0518	1·053	
Degrees Balling or Brix......	16·5	15·4	17	19·6	16	14·5	14·6	19·6	15·8	13·4	13·9	
Saccharose in pounds per gallon	1·442	1·300	1·580	1·891	1·357	1·186	1·272	1·847	1·370	1·123	1·156	
Glucose in pounds per gallon.	·109	·150	..	·036	·132	·147	·137	·060	·123	·111	·127	
Quotient of purity	82·2	79·2	86·8	89·3	79 9	77·4	82·4	87·4	82·1	79·7	78·6	
Quotient of Non-sugars......	11·6	11	..	9	12·3	13	8 8	9·7	9·7	12 5	8·6	
Gallons of juice per acre	4,364	6,626	2,938	2,742	4,597	6,606	3,436	5,988	3,410	6,654	2,859	
Tons of saccharose in the juice per acre.............	2·61	3·84	2·07	2·28	2·48	3·49	1·9	4·94	2·37	2·33	1·40	
Tons of commercial sugar obtained per acre	2·18	2·96	1·64	..	2·17	2·93	1·61	..	2·03	2·80	1·15	
Quality of the megass	Very poor to good	Good	Good	..	Bad to good	Poor	Bad	..	..	..	..	
Total number of Experiments reported	11	..	..	..	8	..	..	..	13	..	..	
Acres reaped Experimentally.	1,104	..	..	..	44	..	..	..	380	..	..	

Name or Number of Canes ..	No. 74.				B. 147.				No. 109.			
	Plantations.			Botanic Gardens	Plantations.			Botanic Gardens	Plantations.			Botanic Gardens
	Means.	Highest Yield.	Lowest Yield.	Means.	Means.	Highest Yield.	Lowest Yield.	Means.	Means.	Highest Yield.	Lowest Yield.	Means.
Description of canes	Plants and Ratoons	Plants	Plants	Ratoons	Plants and Ratoons	Plants	Ratoons	Ratoons	Plants and Ratoons	Plants	Plants	Ratoons
Age when cut (in months) ..	11 to 13	12	13	11	11 to 15	11	12	11	11 to 13	11	11	15
Acres reaped	1 to 21	16	21	..	1 to 100	17	11	..	1 to 61	20·1	1	..
Average yield of canes in punts or tons per acre	31·1	51·7	25·4	38·3	31·9	43·9	18·6	53·3	31·1	48·9	24·7	32·2
Milling quality	Fair to good	Fair	Good	Fair	Moderate to good	Good	Good	Good	Bad to good	Fair	Medium	Good
Normal Juice.												
Specific gravity, $\frac{30\ 0}{16\cdot 8}$	1·062	1·0584	1·061	1·074	1·0607	1·055	1·0584	1·073	1·0551	1·0502	1·063	1·0809
Degrees Balling or Brix......	16·0	15	15·8	18·8	15·7	14·2	15	18·6	14·4	12·9	16·2	20·3
Saccharose in pounds per gallon	1·375	1·287	1·303	1·624	1·310	1·229	1·323	1·676	1·294	·950	1·380	1·920
Glucose in pounds per gallon.	·114	·089	·148	·096	·120	·129	1·26	·113	·118	·142	·100	·069
Quotient of purity	81	81	77·6	80·4	78·7	82	78·9	84	85·2	71·3	79·6	87·3
Quotient of Non-sugars......	12·3	13·4	13·6	14·8	14·1	9·3	15	10·3	7	16·8	14	9·6
Gallons of juice per acre	4,184	6,246	3,076	5,831	4,196	6,420	2,562	7,545	4,215	7,290	2,910	4,750
Tons of saccharose in the juice per acre.............	2·48	3·58	1·78	4·23	2·40	3·44	1·51	5·64	2·42	3·09	1·80	4·06
Tons of commercial sugar obtained per acre	2·03	3·00	1·50	..	1·99	2·88	1·07	..	1·91	2·59	1·26	..
Quality of the megass	Fair to useless	Bad	Fair	..	Very poor to very good	Good	Good	..	Very bad to good	Very bad	Very bad	..
Total number of Experiments reported	9	..	..	..	13	..	..	..	12	..	..	..
Acres reaped Experimentally.	49	..	..	..	283	..	..	..	225	..	..	..

Name or Number of Canes......	No. 78.			
	Plantations.			Botanic Gardens.
	Means.	Highest Yield.	Lowest Yield.	Means.
Description of canes	Plants and Ratoons	Plants	Plants	Ratoons
Age when cut (in months)	10 to 13	11	13	12
Acres reaped	1 to 45	8	17	..
Average yield of canes in punts or tons per acre	22·5	31	20·1	30·5
Milling quality	Bad to fair	Bad	Hard	Fair
Normal Juice.				
Specific gravity, $\frac{80}{16}\cdot\frac{0}{6}$...........	1·0598	1·0498	1·055	1·0692
Degrees Balling or Brix	15·5	12·8	14·2	17·7
Saccharose in pounds per gallon..	1·236	·888	1·086	1·67
Glucose in pounds per gallon	·138	·113	·160	·039
Quotient of purity	75·3	66·1	72·4	85·4
Quotient of Non-sugars	19·5	25·5	17	12·5
Gallons of juice per acre.........	3,334	4,926	2,489	4,059
Tons of saccharose in the juice per acre........................	1·70	1·95	1·2	2·62
Tons of commercial sugar obtained per acre........................	1·39	1·63	1·01	..
Quality of the megass............	Bad to fair	Fair	Bad	..
Total number of Experiments reported	7	..	..	..
Acres reaped Experimentally	93	..	..	..

The striking differences between the results obtained on the estates and those on small plots at the Botanic Gardens are well brought out in these experiments. For the sake of clearness these differences are given in the form of a table :—

Name or Number of Cane	625		95		Bourbon.		145	
	Estates	Gardens.	Estates	Gardens.	Estates	Gardens.	Estates	Gardens.
Tons of Saccharose in the Juice per Acre	3·50	5·65	2·72	2·56	2·61	2·28	2·48	4·94

Name or Number of Cane..	74		147 B.		109		78	
	Estates	Gardens-	Estates	Gardens.	Estates	Gardens.	Estates	Gardens.
Tons of Saccharose in the Juice per Acre	2·48	4·23	2·40	5·64	2·42	4·06	1·70	2·62

The Results of 1902.

Recently irrigation experiments have been started at the Botanic Gardens at British Guiana, the preliminary results of which have been published in the *Demerara Chronicle*. On account of their interest and great promise they are reproduced in full:—

"The results for 1902, of the seedling cane experiments, carried on in connection with the Botanical Department, in the field behind the Botanic Gardens and in the field in the Brickdam, under the supervision of Professor Harrison, C.M.G., are highly gratifying. The average yield of canes in the field adjoining the Gardens has been 78·8 tons to the acre. These results were obtained on new land, irrigated under modern conditions, and are evidence of the enormous yields obtainable under these conditions. Below are the yields of the various seedlings:—

Seedling No.	Yield of canes per acre. Tons.	Sucrose per gall. of juice. lbs.	Seedling No.	Yield of canes per acre. Tons.	Sucrose per gall. of juice. lbs.
625	82·8	1·769	115	66·7	1·710
116	76·8	1·747	109	65·9	1·758
130	75·7	1·699	3,956	62·1	1·713
145	70·8	1·814	74	59·6	1·800
78	68·1	1·640	95	59·1	2·077

"In the Brickdam field, the following varieties have given better results than the Bourbon, which gave 28·1 tons of canes per acre, the juice containing 1·775 lbs. of sugar to the gallon:—

Seedling No.	Canes per acre. Tons.	Sucrose per gall. of juice. lbs.	Seedling No.	Canes per acre. Tons.	Sucrose per gall. of juice. lbs.
115	35·9	1·816	74	30·7	1·796
130	34·9	1·920	2,028	32·1	1·822
2,468	36·5	1·842	1,880	30·7	1·998
1,087	43·7	1·437	109	35·7	1·645
625	40·5	1·645	145	31·6	1·900
B 147	42·1	1·572	102	26·5	2·071
3,157	30·3	1·874	White Transparent	26·5	1·892
1,640	30·5	1·608			
132	34·2	1·759			

The Effect of a Year's Irrigation.

"In connection with the results published above, it is interesting to note the difference between the returns for the cane crop season 1901-1902 when the land under cultivation at the Botanic Gardens was practically devoid of irrigation, and those for the season just ended, which represent what can be done on newly cultivated land of which the irrigation is carried out in a systematic and thoroughly practical manner. The following table shows the increase in tons of

the yield per acre of seedlings which were under cultivation both in 1901-02 and 1902-03, this increase being solely due to the changed conditions under which the cultivation has been carried on. The increase and decrease in the sucrose contents of the cane juice (per gallon) are also given.

Seedling No.	Increase in yield of canes per acre. Tons.	Saccharose in pounds per gallon. Increase.	Decrease.
95	39·2	·109	..
78	37·6	..	·030
109	33·7	..	·162
625	30·7	·233	..
145	30	..	·033
74	21·3	·470	..

"It will be noticed that only in three instances has there been an increase in the sucrose contents of the juice. It must be borne in mind, however, that any increase whatever is a remarkable feature, for the general result of an increase in the yield of canes is a decrease in the saccharose quality of the juice. The enormous yield per acre in the case of D 625 (82·8 tons) and indeed in all the seedlings mentioned in the tables given last week, clearly indicates that on fairly good soil in this colony,—soil which has not been under cultivation for a long time and in regard to which the conditions of drainage and irrigation are properly looked after, results can be obtained equal to those reported from the cane fields of Hawaii."

The Colony of British Guiana is to be congratulated on the work so ably conducted and so lucidly expressed by its Official Chemist, Professor Harrison. The results already obtained constitute an important landmark in the history of West Indian Agriculture, and it is no exaggeration to say that they exceed in value and interest all previous memoirs on sugar cane cultivation in these Colonies. The close and cordial co-operation which exists between the planters and Professor Harrison augurs well for the future, and the results from year to year will be eagerly looked forward to by all interested in the welfare of the sugar cane industry. Not only is this work of immediate value to the Colony of British Guiana, but it serves as an object lesson for investigators elsewhere. It is hoped that other workers on the improvement of the sugar cane in the West Indies will profit by the example set by British Guiana, and as time goes on produce results of value to the planters in the various sugar growing colonies.

ALBERT HOWARD.

Messrs. McConnell, of Demerara, have recently ordered two sets of plant for the manufacture of molascuit.

BRITISH *versus* AMERICAN CANE MILLS.

In our February number we had occasion to comment on the fact that a Demerara plantation firm could find no suitable pattern of British nine-roller mill, and had to place their order in America. Exception was taken in our correspondence columns to the conclusions we drew, but we saw no reason to materially modify them, and gave our reasons for the line we took. The Demerara *Chronicle* has subsequently confirmed our view, for the following is its comment on the matter:—

"The *International Sugar Journal* calls attention to the fact that the British cane sugar machinery manufacturers are in danger of yielding their supremacy to American competitors, and quotes as confirmatory evidence the experience of the Pln. Diamond proprietors in this colony, who last year imported the American Fulton nine-roller mill for their factory, having failed to find anything to equal it in the workshops of Great Britain. The manager of the well-known British firm of Messrs. George Fletcher & Co. thereupon writes to the *Sugar Journal* stating that his firm has turned out plants very similar to the one in question. This may be, but at the present time the Americans produce more efficient sugar mills than the British manufacturers. For many years to come there will probably be a demand in the colony for British mills, if for no other reason than that the cost of the Fulton mill is prohibitive to the owners of the smaller estates, but there can be hardly any doubt that the home firms are outdistanced in competition by their American competitors in the manufacture of cane-crushing machinery, and they are fated to lose the large trade in machinery formerly done with the West Indies unless they wake up to the fact that the three-roller mills must be superseded on the larger estates by more up-to-date crushing methods. Nor can it be said that the British manufacturers produce an engine suited for sugar factories as powerful and as economic as the Corliss engine, also of United States' workmanship, which has lately been installed at Pln. Diamond. Regrettable as these facts may be their accuracy cannot be impeached, and it is for the British firms to realise the truth rather than delude themselves with the belief that the American machinery was purchased by the proprietors of Diamond estate 'because America was practically the only market for Demerara sugar.' The only considerations that counted with the estate's authorities in purchasing their new plant in the United States were those of efficiency."

A new and very complete sugar experiment station is about to be started in Porto Rico under the control of the United States Government. To that end, 230 acres of suitable land have been secured.

PUBLICATIONS RECEIVED.

Technical Mycology: the Utilisation of Micro-organisms in the Arts and Manufactures. Vol. II. Eumycetic Fermentation. Part I. By Professor Franz Lafar. Translated by Charles T. C. Salter. London: Charles Griffin & Co., 1903. pp. 189. Price 7s. 6d.

In perhaps no other department of applied science is the necessity of a critical compilation of a scattered literature so acute as in the field of technical mycology. The task of bringing together, in concrete form, the vast mass of literature dealing with "fermentation" and the industries dependent thereon, commenced by Professor Lafar in 1896, is now approaching completion. The first portion of the second volume, dealing with the economic aspect of the higher fungi (*Eumycetes*), is now before us in the form of an English translation from the pen of Mr. Charles Salter, the translator of the first volume published in this country in 1898. All interested in this subject will welcome the announcement made by the publishers, that the second and concluding part of Vol. II. will be issued as soon as the German proofs come to hand.

The present instalment of Professor Lafar's work falls into three sections, the first dealing with the morphology of the higher fungi, the second with the interesting group of 'moulds' comprised in the genus *Mucor*, and the third with the yeast family. It is with the last portion of the volume that those connected with the sugar industry will be most interested, and it is a pleasant duty to draw attention to the masterly manner in which this part of the subject has been presented. After considering the morphology of the yeasts in detail, two chapters deal with the anatomy and chemistry of the yeast cell itself. It is inevitable in treating a branch of science which is being added to almost daily, that there should be omissions. That the significance of Barker's work on the morphology of yeasts, should have escaped attention seems, however, somewhat surprising.

It is to be regretted that, in the general scheme of the work, the references to original memoirs, indicated in the text by numbers, should be published as an appendix to the second volume. This circumstance will, to some extent, render the work less useful than might have been the case to investigators on sugar fermentation questions in the tropics where the want of good reference libraries renders it difficult to consult all the important papers on any particular point. A bibliography, such as that foreshadowed in the present work will, when issued, to a great extent remove the disability under which workers in the tropics now labour. The early publication of the concluding part of the work containing this list is therefore highly desirable.

Apart from this weakness, the volume before us is in every respect

admirable. It should find a place in the library of every sugar estate chemist and of all workers on the improvement of the sugar cane in the tropics. A. H.

Anleitung zur Untersuchung der für die Zuckerindustrie in betracht Kommenden Rohmaterialien, Producte, Nebenproducte und Hilfssubstanzen. By Dr. Prof. von Frühling. Braunschweig, Friedrich Vieweg & Sohn. Paper, Mk. 12; Cloth, Mk. 12·80. 496 pp.

A valuable encyclopædia for sugar chemists and managers acquainted with German. It contains innumerable analyses and methods of analysis dealing with sugar, juices, molasses, char, water, limestone, strontia, acids, fuels, and artificial manures. Almost every estimation that a sugar chemist is likely to make is described in these pages, and accompanied by all necessary diagrams and illustrations. Some 40 pages are devoted to reagents and their use and action. The method of employing all the instruments, such as polariscopes, is described in detail.

Wilson's Equivalent of English Pounds and Kilograms. Effingham Wilson, Royal Exchange, London. 2s. 6d. net.

One of those useful little books appearing from time to time, with the object of saving one the labour of an arithmetical calculation whenever a conversion of weights is desired. Providing you can lay your hand on the book at once, it is also convenient for finding out the equivalent in cwts. and qrs. of a given number of lbs. up to four figures.

Immigrant's Guide to Peru. To be obtained from 104, Victoria Street, Westminster, or the Peruvian Consul, Southampton.

A small illustrated pamphlet of some 55 pages, giving information on the industries and agricultural pursuits of Peru. The installation of central sugar factories in that country is considered indispensable; but apart from this, the growing of sugar is certain to prove remunerative.

The Louisiana Sugar Report, 1900-01. By A. Bouchereau. 325, Camp Street, New Orleans. Price, $3·00.

Correspondence.

THE SUGAR INDUSTRY IN THE HAWAIIAN ISLANDS.

To the Editor of "The International Sugar Journal."

Sir,—I was very much amused by "Hawaiian's" letter in your January Number, commenting on Mr. Norman Lamont's article on the Sugar Industry of the West Indies.

Hawaii is indeed ahead both in the economical and at the same time most profitable methods of culture and manufacture, so much so

in fact that chemists fitly fill the positions they now hold on the plantations here.

Had "Hawaiian" not been a master of perversion he would have told you of the Planters' Association Experimental Station here, where analysis of soils can be made, or of fertilizers for particular soils, where also experiments are being continually made in all manner and ways of cultivation.

The majority, I may say all of the plantations on these Islands, have the sugar boiler in charge of the boiling house, and rightly so, as all are men of years of experience in the practical work of the house, which experience to my knowledge no one chemist has, who are therefore incompetent, and whom to have in charge would be absurd. Chemists make determinations of the extraction, have the juices measured, give the sucrose, glucose and purity, and the acidity or alkalinity of the clarified juice, together with the brix and purity of the masse and molasses, all appearing in the daily report to the manager, who gives instructions to the engineer or sugar boiler of any change he may wish made. Were chemists to be in charge of the whole works, as I take "Hawaiian" to advocate, where would the manager come in? Would it not be he, then, who would be a kind of understudy to the chemist?

Again, were chemists to be in charge they would be reporting on their own work and it is only reasonable to suppose that no mere man is likely to put on record that which may be of an inferior order. I recollect hearing of one case where a chemist who was in charge (chemists have been in charge, but their services in that capacity were dispensed with) gave his report running waste molasses at 35 purity, but on the manager submitting a sample to outside analysis he was informed the purity was 49.

The Hawaiian Sugar Planters' Association is a radical and energetic body, ever on the outlook for new and improved methods in field and mill work and spare no expense giving new ideas a trial, and who, nevertheless, believe the method, so far as chemistry is concerned, now in vogue the most economical and profitable.

The great Ewa Plantation on the Island of Oahu is a proof for what I have said, whose manager is a man of his whole lifetime's experience in the business, who has world's records for amount of cane and sugar per acre, and for economic and wellnigh perfect work in the mill and boiling house.

Anyone in the business who has travelled in other sugar producing countries could not fail in giving the Hawaiian Islands the premier position, and to have great respect for the Hawaiian Sugar Planters' Association.

I am, &c.,

AMERICAN.

Honolulu, February 13th, 1903.

IMPORTS AND EXPORTS OF SUGAR (UNITED KINGDOM),

To end of March, 1902 and 1903.

IMPORTS.

Raw Sugars.	Quantities.		Values.	
	1902.	1903.	1902.	1903.
	Cwts.	Cwts.	£	£
Germany	2,961,440	1,039,338	1,067,296	413,656
Holland	162,717	103,465	54,008	38,968
Belgium	326,278	259,911	120,839	107,091
France	1,181,920	71,216	474,507	32,967
Austria-Hungary	49,774	926,446	17,450	386,261
Java	....	....	....	....
Philippine Islands	....	70,646	....	25,285
Peru	46,367	45,414	16,212	16,849
Brazil	139,469	31,481	47,643	11,996
Argentine Republic	458,372	55,543	174,151	24,060
Mauritius	61,847	61,353	22,635	21,565
British East Indies	29,382	55,478	14,239	21,054
Br. W. Indies, Guiana, &c.	222,972	120,407	141,783	74,167
Other Countries	54,635	86,906	23,675	37,580
Total Raw Sugars	5,695,173	2,927,604	2,174,438	1,211,499
Refined Sugars.				
Germany	5,377,722	3,077,372	2,859,487	1,589,242
Holland	896,329	538,189	529,975	312,626
Belgium	81,756	33,212	48,143	19,320
France	1,566,394	191,927	802,690	113,221
Other Countries	2,268	286,530	1,395	142,049
Total Refined Sugars	7,924,469	4,127,230	4,241,690	2,176,458
Molasses	311,845	395,962	69,021	74,659
Total Imports	13,931,487	7,450,796	6,485,149	3,462,616

EXPORTS.

British Refined Sugars.	Cwts.	Cwts.	£	£
Sweden and Norway	11,252	5,438	6,852	2,841
Denmark	42,208	18,458	22,985	9,471
Holland	13,020	15,485	6,919	8,427
Belgium	2,740	2,265	1,440	1,100
Portugal, Azores, &c.	2,764	1,521	1,545	862
Italy	7,494	2,448	3,635	1,129
Other Countries	86,735	116,938	56,528	70,923
	166,213	162,553	99,904	94,753
Foreign & Colonial Sugars.				
Refined and Candy	8,431	5,495	5,540	3,826
Unrefined	15,994	10,052	8,348	5,332
Molasses	821	43	248	33
Total Exports	191,459	178,143	114,140	103,944

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1903. Tons.		1902. Tons.
Total Receipts, 1st Jan. to April 16th ..	452,153	..	401,855
Receipts of Refined ,, ,, ,, ..	252	..	2,946
Deliveries ,, ,, ,, ..	409,003	..	393,908
Consumption (4 Ports, Exports deducted) since 1st January	380,209	..	414,223
Importers' Stocks (4 Ports) April 15th ..	47,535	..	33,258
Total Stocks, April 22nd	213,000	..	115,895
Stocks in Cuba ,, ...	350,000	..	407,289
	1902.		1901.
Total Consumption for twelve months ..	2,566,108	..	2,372,316

CUBA.

STATEMENT OF EXPORTS AND STOCKS OF SUGAR, 1902 AND 1903.

(Tons of 2,240lbs.)	1902. Tons.		1903. Tons.
Exports	100,782	..	178,676
Stocks	407,458	..	362,996
	508,240	..	541,672
Local Consumption (three months)	11,150	..	11,380
	519,390		553,052
Stock on 1st January	19,873	..	42,530
Receipts at Ports up to 31st March ..	499,517	..	510,522

J. GUMA.—F. MEJER.

Havana, 31st March, 1903.

UNITED KINGDOM.

STATEMENT OF IMPORTS, EXPORTS, AND CONSUMPTION FOR THREE YEARS.

From *Produce Markets' Review.*

SUGAR.	IMPORTS. 1903. Tons.	1902. Tons.	1901. Tons.	EXPORTS (Foreign). 1903. Tons.	1902. Tons.	1901. Tons.
Refined, Jan. 1st to Mar. 31st	206,365	396,223	285,774	274	421	1,320
Raw, ,, ,,	146,380	284,758	272,588	502	800	1,389
Molasses, ,, ,,	19,798	15,592	23,930	2	41	1,217
Total	372,543	696,573	582,292	778	1,262	3,926

	HOME CONSUMPTION. 1903. Tons.	1902. Tons.	1901 Tons.
Refined, Jan. 1st to Mar. 31st	193,834	401,049	—
Raw, ,, ,, ...	132,159	302,242	—
Molasses, ,, ,, ...	17,800	16,776	—
Total	343,793	720,067	—
Less Exports of British Refined	8,127	8,310	—
Net Home Consumption of Sugar	335,686	711,757	479,565*

* Trade estimate.

STOCKS OF SUGAR IN EUROPE AT UNEVEN DATES, APRIL 1ST TO 22ND, COMPARED WITH PREVIOUS YEARS.
IN THOUSANDS OF TONS, TO THE NEAREST THOUSAND.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	TOTAL 1903.
108	1133	734	499	248	2723

	1902.	1901.	1900.	1899.
Totals	2850 ..	2164 ..	1973 ..	1973

TWELVE MONTHS' CONSUMPTION OF SUGAR IN EUROPE FOR THREE YEARS, ENDING MARCH 31ST, IN THOUSANDS OF TONS.

Great Britain.	Germany.	France.	Austria.	Holland, Belgium, &c.	Total 1902-03.	Total 1901-02.	Total. 1900-01.
1471	883	553	398	528	3833	4186	4278

ESTIMATED CROP OF BEETROOT SUGAR ON THE CONTINENT OF EUROPE FOR THE CURRENT CAMPAIGN, COMPARED WITH THE ACTUAL CROP OF THE THREE PREVIOUS CAMPAIGNS.

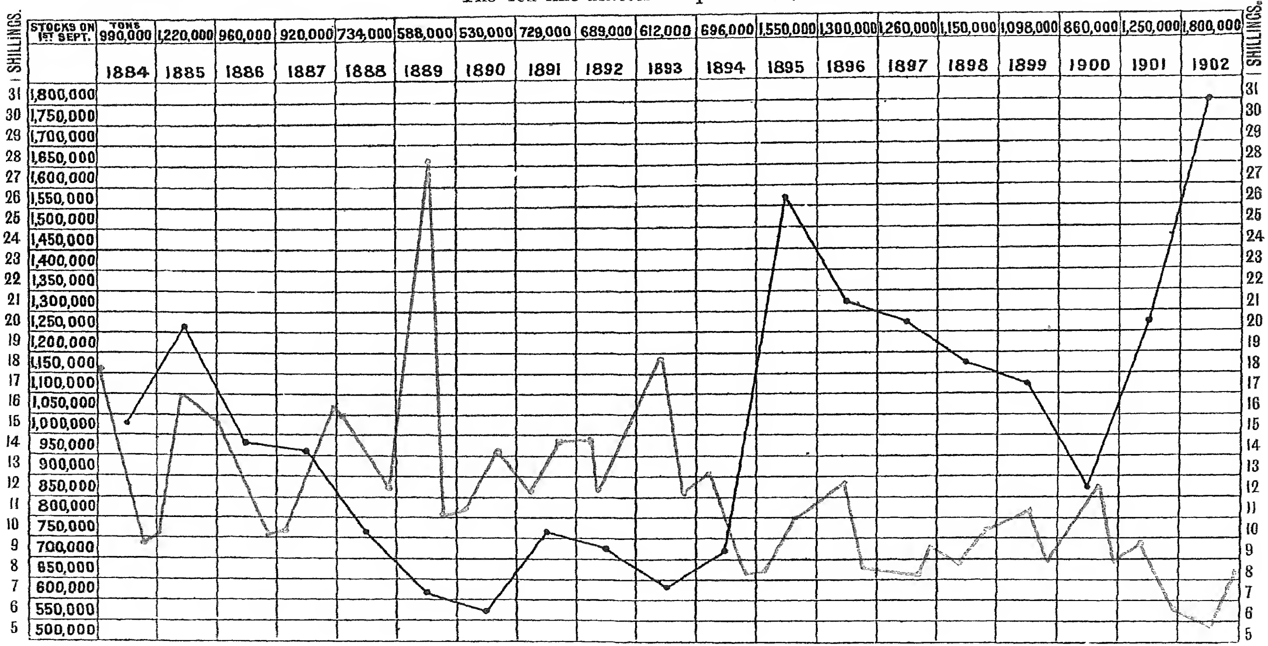
(From Licht's Monthly Circular.)

	1902-1903. Tons.	1901-1902. Tons.	1900-1901. Tons.	1899-1900. Tons.
Germany	1,750,000 ..	2,304,924 ..	1,984,186 ..	1,798,631
Austria	1,070,000 ..	1,302,038 ..	1,094,043 ..	1,108,007
France	890,000 ..	1,183,420 ..	1,170,332 ..	977,850
Russia	1,215,000 ..	1,098,983 ..	918,838 ..	905,737
Belgium	230,000 ..	334,960 ..	393,119 ..	302,865
Holland	105,000 ..	203,172 ..	178,081 ..	171,029
Other Countries.	345,000 ..	393,236 ..	367,919 ..	253,929
	5,605,000	6,820,733	6,046,518	5,518,048

DIAGRAM ILLUSTRATING CONTEST BETWEEN PRODUCTION AND CONSUMPTION, AND CONSEQUENT FLUCTUATIONS IN THE PRICE OF SUGAR.

When the black line rises, production is exceeding consumption; where it falls, consumption is exceeding production.

The red line denotes the price of 88% beet.



THE

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☞ All communications to be addressed to The Editor, Office of *The Sugar Cane*, Altrincham, near Manchester.

All Advertisements to be sent *direct*.

Cheques and Postal Orders to be made payable to Norman Rodger, Manchester.

☞ The Editor is not responsible for statements or opinions contained in articles which are signed, or the source of which is named.

Blyth Bros. & Co., Mauritius, report shipments of sugar from August 1st to April 3rd as 109,157 tons, against 96,288 tons in the corresponding period of 1901-02.

The Government and the Budget Bill.

It is becoming apparent that the Government intend to postpone the Sugar Bill to the end of the session, in other words, till August. This delay in giving effect to the provisions of the Brussels Sugar Convention is to be regretted. The impression thereby created in the minds of the foreign States, parties to the Convention, may be anything but favourable, and they might well be asking whether Great Britain intends to blunder out of the whole question at the eleventh hour. By the time these lines appear, the International Commission will have met at Brussels, in compliance with the stipulation that it was to assemble not later than the last day of May, and doubtless will then have promptly adjourned over Whitsuntide. When it does settle down to business, will the British representatives inform the meeting that they have no details to submit as to how the new customs regulations, rendered necessary by the terms of the Convention, will be carried out in this country? Or will a draft of the new Bill (which might subsequently have to be amended) be submitted to the Convention for its approval? In any case, while we do not for a moment suppose the Government are hesitating to carry out the provisions they have undertaken to observe, yet their tardy action, or

rather want of action, can hardly strengthen their position. But for the protracted debate over the Education Bill, the whole matter might have been settled last November.

International Congress of Applied Chemistry.

The International Congress of Applied Chemistry, to be held in Berlin at the beginning of this month, promises to be a very valuable conference. The Sugar Section is a very large one as regards the number of papers to be read, and we can do no more than mention a few of the latter here; we shall, however, endeavour where possible to supply our readers with translations of the most important ones. The list includes "The Naudet Diffusion Process," by E. Silz, Paris; "Concerning the Rôle played by Lime in the Manufacture of Sugar," by A. Aulard, Genappe; "New Studies in Saturation," by K. Andrlik, Prague; "Table Syrup," by S. Stein; "The Loss of Sugar in Refinery Practice," by Professor Dr. von Lippmann, Halle on Saale; "Influence of Environment on the Composition of the Sugar Beet," by Dr. Wiley, Washington.

The Sugar Industry in Madeira.

The Madeira sugar industry owes its origin and maintenance to the very high import duties; these are nearly 300% *ad valorem.* The cane is grown on the sea coast all round the island, and is sold to the manufacturers at a price stipulated by the Government which averages 53s. per ton! It may be taken for granted that as nearly as possible total exhaustion of the canes is thereby rendered necessary if the sugar manufacturer is to pay his way. We learn that Naudet's diffusion process has just been given a fair trial, and the results have been very satisfactory. The sugar was extracted from the megass with a loss of but 0·40%. This, while not so good as Geerligs' figure of 0·16%, is nevertheless a very efficient one. As there has been some enquiry of late for a description of this process and its working, we might mention that we propose shortly to publish an article, describing the details of the Madeira trials.

In appears that we were incorrect in describing the position of Mr. George Martineau, on the International Commission at Brussels, as that of *Expert Adviser;* his official title is "Assistant Delegate" (Délégué adjoint).

According to Customs Circulars issued by the Indian Government, the duties imposed on the importation of Russian sugar into India have been revised again. The new rates amount to Rs. 9. 10. 2. on refined and nearly Rs. 6 per cwt. on unrefined sugar. This revision places Russia on a similar footing with those other countries against whom countervailing duties are enforced.

AMERICA AND THE BRUSSELS CONVENTION.

The *Louisiana Planter* in a recent issue ventured to discuss the probable effects of the Brussels Convention on the sugar position in the United States, but its conclusions are by no means as lucid and enlightening as could have been wished. This is one of the aspects of the problem created by the Sugar Convention which has scarcely received the attention it merits. Though America promises in the course of another five years (a period, which peculiarly enough, coincides with the minimum term of the Convention) to produce sufficient sugar, with the assistance of her dependencies, to meet all local requirements, she is still a large consumer of foreign sugar. Notwithstanding her domestic production and her cane imports from the Caribbean the prices in the American sugar market are still ruled by the beet interests of Europe. The state of the market in Berlin and Vienna determines also the quotations for sugar ruling in Wall Street. Undoubtedly, therefore, if Germany, Austria-Hungary, and France fulfil the agreement to which they have recorded their adhesion, as it now appears they inevitably will, a material change will automatically occur in the fiscal system of the United States so far as it effects the beet sugar of the European Continent. The *Louisiana Planter* does not quite appreciate the character and extent of the modification that is impending. "As we understand it," says the leading sugar paper of the Southern States, "America will continue to levy countervailing duties on practically all European beet sugars," inasmuch, explains the *Planter*, as "the various countries interested, while exporting sugars largely, will levy the surtax or duty on foreign sugars and thus maintain home prices at the import level established, and with all their surplus product enter the markets of the world with a practical bonus already got from their own home consumers." It has often been a source of wonder to us that the American Protectionist newspapers, while absolutely blind to the shortcomings of their own fiscal system, can see with such clearness the defects of the protective tariffs of foreign countries. Undoubtedly the sugar manufacturers of Germany and Austria-Hungary will reap the full advantage of the margin of protection which the surtax (from 5·50 to 6 francs per 100 kilog.) fixed by the Convention will afford them. They have actually renewed their kartels to enable them to do so. Every cent of the surtax will thus be paid out of the pockets of the domestic consumers to the sugar manufacturers, who have formed a combination to sell their sugar in the home market at the highest price which the tariff will permit without risking competition from outside. The practice is hardly consistent with the spirit of the Convention, since the surtax was granted not to enable the domestic sugar interests to wring a bounty on export from the home consumers but simply in order to

secure the domestic market to the domestic producer. The *Louisiana Planter* anticipates, however, that the United States authorities will regard this surtax as a bounty, which evidently the manufacturers are trying to make it, and will countervail it accordingly. That appears to be the logical sequence of a countervailing policy such as America has chosen to adopt; but the *Planter* argues itself rather ill-acquainted with the methods of America when it states that the Customs authorities of the Republic will continue to countervail after the ordinary bounties have been withdrawn. The United States will do nothing of the kind. At the present moment the surtax (*i.e.*, the difference between the Excise and the Customs rates of duty) in most sugar-producing countries of Europe is nearly four times what it will be under the provisions of the Convention; yet the United States affect at present to be unaware of its existence, although it operates as a bounty for all practical purposes. The influence of the kartels on the price of sugar exported by Germany and Austria-Hungary for foreign consumption, in Great Britain and America, is simply ignored by the authorities of Washington. Yet had they closely examined the question they would have found almost as good reason for countervailing the results of the kartels on prices as for retaliating against the State-regulated sugar export of Russia. It amounts to this, that in the past the system of countervail followed in the American Republic has been neither equitable nor consistant. Only the ordinary subsidies such as appear on a cursory glance at the fiscal *régimes* of Germany and the Austrian Empire have been countervailed. No account has been taken of the manner in which the sugar interests of the Continent employed the margin of protection which the State afforded them to their own advantage in foreign countries. Indeed, America could not consistently do so. A protective country itself, the Republic's manufacturing interests utilise the local consumer as the agent whereby they succeed in underselling their competitors of England and Germany. By securing an unwarranted profit in the domestic market, the consequence of a high "tariff wall," the United States' manufacturers are able to sell their articles at less than cost price in foreign markets. In other words, in the industrial scheme of America the kartel operates quite as aggressively as it works in the case of the sugar industry of the leading nations of Europe. If, then, America is at liberty to countervail the inevitable effects of a protective tariff, it would follow on the *Louisiana Planter's* plea that every country in the world drawing supplies from the United States would be justified in countervailing United States' products to the extent to which those products are protected in the home market. That is a logical conclusion of a protective system, but if put in force it would literally ruin the great bulk of America's foreign trade. Because of these considerations Washington has played the part of wisdom in pretending to be unconscious of the real significance of the kartels. We are

quite certain that the failure of the States to impose a punitive tariff against the sugar combinations of Europe arises from the dread lest such a policy would provoke the war of tariffs which seems to be impending and in which America stands to suffer most. In such a struggle Great Britain is the only nation which can afford to look on with complacence, since she refuses to fight the battles against *protection with protectionist weapons.* America will *not continue to* countervail the beet sugar of Europe when the Convention becomes an actuality; on the contrary, if she is consistent in following out the policy initiated on the adoption of the Dingley Tariff the present system of countervail will suffer complete collapse. Formal notification will be conveyed to Washington by the European Powers (with the single exception of Russia) that the payment of bounties has ceased, whereupon the compensatory duties will automatically cease to apply. On the other hand, let us suppose that the United States' sugar industry were to prosper so well that she or her dependencies—Hawaii for example—could afford to ship sugar to any country in Europe signatory to the Convention. On what terms would such sugar be admitted? The present Dingley tariff, needless to say, applies to Hawaii as well as to the United States. But Hawaiian or Louisiana sugar could be denied admission altogether or could be countervailed, even in England, unless the amount of the protection it receives were reduced to from 5·50 to 6 francs per 100 kilog, or about 2s. 6d. per cwt. America, in other words, cannot become a party to the Sugar Convention until she is prepared to reduce her protective duty to the margin prescribed by Article III.—(*Demerara Chronicle.*)

ON THE SPECIFIC GRAVITY OF MOLASSES.

By Ernest E. Hartmann.

The Density of Molasses is usually found by dilution and subsequent spindling or determination of the specific gravity of the diluted molasses by pyknometer.

This method, as I propose to demonstrate here, yields invariably results which show too high a specific gravity, the error increasing with the degree of dilution. The discrepancies between results obtained by different dilutions increase with the content of non sugars in the molasses, and vary with the composition of the mineral contents.

In a solution of pure sugar the same density will be found by direct determination and by dilution.

Average analysis of the molasses used for the following comparisons:—

Water	18·54
Sucrose	35·44*
Glucose	20·27
Gums	3·10
Other organic matter	10·80
Ash	11·85
	100·00
Nitrogen	·523
Alkalinity	·112% CaO

ANALYSIS OF ASH.

CaO	10·05
MgO	2·12
K_2O	40·57
Na_2O	4·62
Fe_2O_3 / Al_2O_3	1·84
P_2O_5	1·40
SO_3	13·62
SiO_2	1·88
Cl	24·25
CO_2 and diff.	5·19
	105·54
O equal to Cl	5·54
	100·00

It was not practicable to expel the air entirely from the undiluted molasses. The highest concentration experimented with was for this reason 80%. The specific gravity was determined by pyknometer for dilutions from 80% down to 10%. The temperature was as much as possible kept the same.

As will be seen in the table below, the values for the different degrees of dilution lie in a fairly regular curve. The values for above 80% and below 10% (given in italics), have been estimated by extension of this curve.

Dilution. Molasses.	Water.	Per cent.	Brix °.
100	*0*	*100*	*90·0*
80	20	80	90·37
70	30	70	90·60
60	40	60	90·91
50	50	50	91·31
40	60	40	91·80
30	70	30	92·38
20	80	20	93·06
10	90	10	93·84
1	*99*	*1*	*94·7*

The actual density as expressed in degrees Brix of the average molasses under consideration, would thus be found to be very near 90·0, while the Brix obtained by mixing one part molasses with

* Direct Polarization 31·88.

three parts of water (the proportion most generally used in the laboratories in these Islands), would be 92·7, a considerable difference.

This peculiar behaviour of the molasses must be ascribed to substances (mineral salts) held in suspension in the concentrated molasses, which on mixing with water are gradually dissolved. In fact, in most of the low grade molasses, which have so far come under my observation, I have found microscopical crystals, which are not readily dissolved by the addition of water.

The quotient of purity obtained by dividing single polarization by Brix as found by dilution method, is of value for the comparison of work in the same sugar house day by day, but for calculation of losses and comparison of work of different factories, sucrose should be determined by Clerget method and Total Solids should be found by determination of water in molasses.

A ROOT DISEASE OF THE SUGAR CANE IN BARBADOS.

By Albert Howard, M.A., F.L.S.,

Botanist to the South-Eastern Agricultural College, Wye; late Mycologist to the Imperial Department of Agriculture for the West Indies.

The most important sugar cane pest which came under my notice in Barbados during the years 1899–1902 was a root disease. In the present paper an attempt is made to present the practical aspect of this trouble and to sum up the results of my observations and experiments relating thereto, a technical account (6) of which was published in the *Annals of Botany* of March last. Such portions of this former paper as appear suitable for the purpose are incorporated in the following.

As the disease under consideration appears to be intimately bound up with the climate and agricultural practice of the Island, some reference to these matters is necessary at the outset. There is a well-marked dry season in the spring, as will be seen from the following table which gives the mean monthly rainfall, from 1892–1901, at one of the stations. The average annual rainfall during this period was 62·85 inches, but the total precipitation on the highlands (above 400 feet) was about 10 inches more than that on the lowlands.

Mean Monthly Rainfall from 1892–1901 both inclusive.

Month.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Rainfall in inches	3·12	1·65	2·72	2·53	3·42	5·03	6·09	8·24	9·08	7·28	7·88	5·81

Planting is usually carried out in November and December and reaping takes place about eighteen months later, from March to June in the second year after planting. Usually the old stumps are allowed to produce a second crop of ratoons, the growing period of which is about a year. On the red soils in the highlands, two or three of these ratoon crops are obtained, but in the lowlands the canes only ratoon once at the most.

As a rule the first crop of canes is healthy, at any rate till growth is completed and the rind (red smut) disease makes its appearance during the ripening period. Sometimes, however, the young canes do not respond to the early rains of the wet season in June and July, practically making no growth and remaining dwarfed. Instead of the twelve to fourteen broad green leaves of normal canes the affected shoots bear from six to ten pale-green narrow leaves, the oldest showing a tendency to dry up from the apex and margin. Even after rain, when the soil contains much moisture, the young leaves in the centre of the tuft assume the vertical position and partly fold up by the inrolling of the two halves of the blade, in the manner described and figured by Wakker (3). This device for preventing loss of moisture is only made use of by healthy canes during drought, but in those in question it is constantly apparent and at once suggests water starvation. The stunted canes never recover, but struggle on, throwing up large numbers of shoots from the buds at the base of the stem. These new shoots in turn become affected like the parents and a clump of dwarfed canes results, resembling one of the phases of the "sereh" disease of the sugar-cane in Java (4). The diseased canes occur in circular patches, which, however, are not sharply marked off from the normal areas, but gradually shade off into them.

It is in the second-crop canes or ratoons of the lowland districts especially that the trouble indicated above is to be seen on a large scale. Often the whole field is uniformly affected, and the contrast between it and a neighbouring first-crop field is most striking. In the former case, the narrow, pale-green, erect and partly folded-up leaves are few in number and the clumps of cane do not meet in the rows; in the latter, the leaves are broad, dark-green in colour, and bend to the breeze with the blade flat and fully exposed to the light. Here the canes meet in the rows, and, when viewed from above, look like solid masses of green. The striking difference between first and second crops on the lowland areas is so general that it seems to have been accepted by the planters as part of the ordinary course of things. The general impression seems to be that the soil is not suited to ratoons. On the red soils in the highland districts this dwarfing of the ratoons, although to be noted here and there in the second crop, is not so general as on the black soils of the lowlands. It makes its appearance, however, to an increasing extent in the third and later crops, and finally leads to the throwing out of the fields. Locally,

the red soils of the highlands are known as ratooning soils, while those of the lowlands, although giving very good first crops, are not regarded as specially suitable for a second crop.

The comparative failure of ratoon crops was found on examination to be due, in most cases, to a definite root disease, some account of which is given below.

Characters of the Disease.

Apart from the peculiarities of the leaves of the dwarfed canes and their marked tendency to throw up shoots from the base, which have already been referred to, there are other characteristics to be observed on a closer examination. As a rule, a healthy cane sheds its old dry leaves as growth proceeds, but in those in question the leaf-sheaths of the dead lower leaves adhere firmly to the stem, being cemented thereto by a white, musty smelling, fungoid growth. Such canes can moreover be pulled out of the ground with ease, when they are seen to possess very few normal roots. They are besides very much lighter in weight than healthy canes of the same size. On stripping off the dead leaf-sheaths at the base of the stem, it is found that most of the roots have either not developed or else have ceased to grow when about a $\frac{1}{4}$ to $\frac{1}{2}$ an inch in length, when they are brown in colour and corky to the feel. The rind of the cane immediately over the undeveloped roots is marked by brownish or blackish spots. Considerable force is required to remove the leaf-sheaths from the part of the stem covered by the soil and to clear the nodes, as the white fungoid growth referred to binds the whole into a solid mass. A portion of the lower part of a sugar-cane stem showing the abnormal development of the lower buds and the aborted roots is shown in Fig. 1, while in Fig. 2 the dwarfed roots from a similar portion of an affected cane are shown on a larger scale. On splitting open the lower portions of the stem, the fibres are often reddish, while towards reaping-time cavities occur in the internodes, in which, when the canes are nearly dead, a white fungus growth can be detected with the naked eye. The still living leaf-sheaths are covered with a white matted growth, and reddish spots are common thereon. Colonies of small, yellowish-white toadstools are to be met with after heavy rains on the lower parts of the diseased shoots (Fig. 3). These persist only for a short time under the most favourable circumstances, and for this reason appear to have escaped attention hitherto. Specimens for examination, or for the production of spores, are best collected as soon after daybreak as possible, as the sun dries them up very rapidly.

The white fungoid growth which cements the old leaf-sheaths to the stem proved to be a branched, septate mycelium, very variable in diameter, which exhibited the clamp-connexions chiefly met with among the Basidiomycetes (Fig. 4).

A similar mycelium was found around the aborted roots, in fact, these were often imbedded in a thick felted mass of hyphae. It was

further detected in great quantity between the still living leaf-sheaths and in the cells of the reddish areas noted on these, and also in the tissues of the aborted roots themselves.

Longitudinal sections of the dwarfed roots showed that the root cap and the tissue of the growing region were invaded in all directions by a fungus which was characterised by clamp-connexions and brown resting-spores (Fig. 4). Most of the invaded tissue of the root was dead, much disintegrated and dark brown in colour in many places. Attempts to branch were frequently made by such roots, but the secondary roots were usually destroyed while making their way through the outer tissues of the parent. The beginning of such attempts is shown in Fig. 5.

The undeveloped roots, which were characterised by brown marks in the rind of the cane immediately over them were found to be destroyed in a very similar manner to those in which growth had been arrested shortly after penetration of the rind. In all cases the growing point tissues were invaded and destroyed by the fungus and further growth rendered impossible. A longitudinal section of one of these diseased roots is shown in Fig. 5.

No matter whether the roots are destroyed after penetration of the parent stem or before this is accomplished, the result is the same, namely, the loss of a possible means of supplying the cane with water and minerals from the soil. When, as in most cases of this disease, by far the greater number of the roots in the below ground portion of the stem are destroyed in this way, as well as those for some distance above the ground, it is clear that recovery is out of the question and that there is no cure for the disease.

If the development of the shoots which arise from the base of the parent stem is followed, it is found that here too the leaf-sheaths become cemented to the stem by the white growth and that the majority of their roots are destroyed as before. It sometimes happens that these shoots die off, when they are found to be penetrated in all directions by a fungus similar in appearance to that in the young roots.

The below-ground portions of the older shoots sometimes contain this mycelium and show reddening and extensive gumming in the fibres. As the reaping period approaches and the supply of water in the soil falls off, large cavities are formed in the canes in which, in cases where they are drying up, a white fungus luxuriates. In a short time such dying canes become infected by the saprophytic fungus *Melanconium* referred to in a previous paper (7).

The toadstools noted on the diseased canes are yellowish white in colour, the cap varying in diameter from 10 to 18 mm.; the curved stalk being about equal in length to the diameter of the cap (Fig 3). As these fructifications reach maturity, the cap becomes flattened and even turned inside out when the toadstool has the shape of a wine

glass, the gills being on the outside of the cup. The gills run right up to the centrally disposed stalk but are not attached thereto. They are arranged in a radial manner and may branch once or twice towards the margin of the cap. The spores are milky white in the mass, irregular in shape with one end somewhat elongated. They measure 15·5 to 18 by 4·5 to 5 μ, and, when fresh, contain oil drops. The toadstools dry up quickly and become tough, but revive when moistened. These characters indicate that this form belongs to Fries' genus *Marasmius*, which, according to Saccardo, includes 450 species, mostly saprophytes of the tropics and sub-tropics.

It now appeared probable that there was a genetic connexion between these toadstools and the white mycelium with clamp-connexions found on the old leaf sheaths. Further, there appeared to be some likelihood that the mycelium referred to was the cause of the non-development of the affected roots, and therefore of the root disease under consideration. Steps were therefore taken to cultivate the toadstool spores and the white mycelium and to reproduce the disease by inoculating healthy canes with pure cultures of these.

Cause of the Disease.

The results of the culture experiments starting from toadstood spores and from the white matted mycelium found on the leaf sheaths of diseased canes were indentical. In both cases dense white growths resulted which often showed a tendency to collect into feathery strands on the walls of the glass tubes and which, in several cases, produced dark coloured branched root-like strands (rhizomorphs). These are shown in Fig. 7.

In no case were toadstools obtained in the cultures. They were, however, produced in the inoculation experiments described below.

With one exception three series of inoculation experiments were made in which the infecting material was obtained from different sources in each case. Thus, in addition to using the cultures obtained from a single toadstool spore and those from the white mycelium on the leaf-sheaths, pieces of the leaf-sheath, obtained from diseased canes, were also employed.

Experiment 1. In the first instance, three young ratoon shoots, about a foot high, were selected for the experiment. After washing with water, portions of six days' old mycelium (developed from a spore) were placed in the axil of one of the lower leaves of two of the shoots and the whole was covered with a clean lamp chimney, cotton-wool being packed around the shoot at the upper end. The third shoot was used as a control. In seven days, the leaf-sheath, on which the mycelium was placed, began to turn yellowish-red, and in fourteen days the whole of this and the next sheath above were covered with a white film of matted mycelium. Reddish areas, where the fungus had invaded and destroyed the tissues, were abundant, and

the leaves attached to these sheaths were rapidly drying up. Sections through the red portions of the leaf-sheaths showed that the cells were penetrated by a mycelium, characterized by clamp-connexions and dark-brown, thick-walled resting spores. The control shoot gave no results. A closely similar set of events followed when culture-mycelium, obtained from the leaf-sheaths of diseased canes, and portions of these leaf-sheaths themselves were employed.

Experiment 2. Three two-eyed cuttings were selected from the upper part of healthy White Transparent canes, carefully washed and placed on moist coral sand, previously sterilized, in flower-pots standing in dishes containing water. These served to keep away ants. The pots were then covered with glass bell-jars and placed in a plant shed. Seven days afterwards, when the cuttings had sprouted, two of them were infected at the cut ends with mycelium (developed from a toadstool spore) similar to that used in experiment 1 above, and the buds were also covered therewith. The third cutting was not infected and thus served as a control. The cuttings were now covered with moist sand. In one case, in seventeen days, and in the other in twenty-nine days after infection, small white circular bodies, about the size of a pin's head, were noted at the surface of the sand on the lower leaf-sheaths of a shoot. In forty-eight hours these developed into toadstools identical with those obtained on cane-shoots attacked by root disease. On examining these shoots it was found that the lower leaf-sheaths were dead and cemented closely by white mycelium to those underneath. The outermost of those still living were covered with mycelium and showed numerous reddish areas, where the cells were found to be invaded by hyphae. The control cutting showed no infection. A similar result was obtained with culture-mycelium from the leaf-sheaths of diseased canes, and in one case toadstools appeared three weeks after infection. With portions of the leaf-sheaths from diseased canes a limited amount of infection was obtained, but no toadstools were produced and the shoots seemed to suffer little from the fungus. During this experiment the cuttings were watered, after the appearance of green leaves, with Sachs' solution.

Experiment 3. Experiment 2 was next repeated, except that sterile soil was used in the flower-pots, and the cuttings were infected when planted, and watered throughout with boiled tap-water. The developing shoots were found to be attacked by the fungus, but in one case only (when pure culture-mycelium had been employed) were toadstools developed during the first month, at the end of which the experiment had to be discontinued. No infection was noted in the controls.

Experiment 4. A small field experiment was next carried out. During planting-time in the early part of December, 1901, the nodes and cut ends of ten healthy White Transparent cuttings were covered

with actively growing mycelium, obtained originally from a toadstool spore, and planted in the ordinary way. Eight of these developed normally, but the other two were destroyed by the fungus *Thielaviopsis ethaceticus*, Went, the shoots dying off shortly after they appeared above ground. In August, 1902, the shoots from these canes were healthy and vigorous and showed no trace of root disease, although white mycelium, characterized by clamp connexions, could be seen as a matted white coating on the scale-leaves of the buds on the below ground portions of these canes.

In the early part of February, 1902, ten similarly infected cuttings were planted in the same field, and were watered just sufficiently for development to take place. After the shoots appeared above ground, the soil around the cuttings was consolidated by treading so as to render root development as difficult as possible. Little growth was made during the dry months of March and April, during which time five of the cuttings died. On examination they and their shoots were found to be penetrated by the fungus in all directions. The remainder showed no response to the rains of May and June, and when examined on August 20 were found to be throwing up shoots from below, and to exhibit all the characteristics of canes attacked by the root disease under consideration. They possessed few roots, the majority having been destroyed, during early development, by the fungus. The rainfall on the field during this experiment is given in the following table.

Rainfall from December, 1901, to July, 1902.

	1901.	1902.						
	Dec.	Jan.	Feb.	March.	April.	May.	June.	July.
Inches of Rain	4·86	·93	·72	·97	·58	3·93	5·80	5·36

In the former case the conditions of growth were distinctly favourable, in the latter unfavourable. The canes planted in December were able to develop rapidly and to establish themselves on their own roots before the dry season. They were able to resist the fungus, although the latter maintained itself on the lower parts of the stem. In the case of the cuttings planted in February, the fungus proved too strong for the canes.

The above results clearly show that the toadstool fungus is a parasite, and that there is genetic connexion between it and the white mycelium found on the leaf-sheaths of the canes attacked by this root disease. Moreover, they serve to complete the life history of the fungus.

In Java, Wakker (2) figured a fungus *Marasmius Sacchari*, n. sp., which destroys cane cuttings in the "hatching beds" in which the

canes are placed before planting out, and also attacks and destroys mature canes. From his description of the fungus, which he regarded as a wound parasite, and his culture and infection experiments, there can be no doubt that the West Indian and Java forms are identical.

Some Relations between the Sugar Cane and the Fungus.

Having established the parasitic nature of the fungus, it became possible to understand the course of the disease more clearly. As already mentioned, the malady, although occurring in first-crop canes, is a much more serious pest among ratoons, especially on the black soils of the lowland districts.

It is a general custom in Barbados to select plant material from ratoon canes, generally from those of the second crop. The cuttings consist either of the upper part of the stem containing the main growing point ("tops"), or of the next portion, and are generally about a foot in length. The selection of plant material from this source seems to be based partly on economic considerations, as such ratoons are poor in sugar, and partly on the fact that these cuttings contain four or five nodes, and thus there is a good chance of one, at least, of the buds developing. As shown in a previous paper (5), it is probable that the greater resistance of such cuttings to fungi like *Thielaviopsis ethaceticus* than that of cuttings from the first crop canes, which are richer in sugar, has been unconsciously found out by experience and has helped to bring about the present practice. It appears likely, however, that planting from the worst canes must eventually lead to the degeneration of the cane varieties under cultivation, and a promising field for investigation seems to be indicated in which the resulting canes from the continued selection of the best and worst cuttings are compared, on an economic scale, for a number of years.

Sometimes the worst canes on the estate are selected for cuttings. In other words, the canes attacked by root disease to the greatest extent are used for the preparation of plant material. On examining these canes it is found that the leaf-sheaths are firmly cemented to the stem by the mycelium of *Marasmius*, which further covers the scale leaves of the buds as a whitish coating.

Marasmius follows the cane through its first year's growth, and sometimes, while the young canes suffer from drought, overcomes them and gives rise to root disease. Generally, however, the favourable conditions for rapid growth of the cuttings in December, and the high condition of tilth during the first crop, enable the canes to develop normally. During this time the fungus is able to hang on, on the lower part of the stem, in a resting condition, where it can be seen as a white-felted mass on the scale leaves of the buds.

When, however, the canes are cut in March, and the closely packed condition of the soil combined with extreme dryness prevents anything like rapid growth of the buds at the base of the cane-stumps, the mycelium, after luxuriating in the rich substratum afforded by these stumps, is able to assert itself and master the young shoots, and thus make up for the long period of waiting. As the new shoots develop with great slowness during the dry season, the fungus has time to destroy most of the roots at the base, at the beginning of their development, and thus to give rise to the dwarfed canes so characteristic of the second crop of the lowlands. When the rains come, only a few roots are available for the supply of water and minerals, and, in spite of the liberal application of artificial manures, practically no growth results.

The fact that the fungus is not so destructive to ratoon canes on the red soils of the highland districts as to those on the black soils of the lowlands, seems to be largely due to the much greater rainfall during the dry season in the former districts than in the latter.

We can to a great extent regard the first and second crop of canes on the lowland districts of Barbados as infection experiments on a large scale with the fungus *Marasmius*. In the case of the first crop, conditions favour the cane and there is little disease. In the second crop, everything helps the fungus and at the same time checks the host, consequently a root disease, epidemic in character, often results. Furthermore, it is caused by a fungus which, under ordinary circumstances, can do little damage, but which, when conditions are against the cane, can become a parasite and even overcome actively growing tissue such as that at the growing-point of the cane-root.

We have, therefore, a striking example of the influence of the environment on the result of the struggle between the host and the parasite, and a confirmation of the views brought forward on this subject by Marshall Ward (1).

Remedies.

It is clear from the fact that the roots of diseased canes are almost entirely destroyed by the fungus that the only measures to be taken are of a preventive character. Further, the cane must be helped as much as possible to withstand the disease.

In the absence of data obtained from large scale estate experiments in connexion with this disease it is only possible to indicate the direction in which it appears likely that results of promise are to be obtained. That such experiments are necessary in the present instance will be evident when it is remembered that some of the more obvious remedies involve drastic changes in the present agricultural practice in Barbados. It is inconceivable that methods which have been stereotyped by a prosperity which, until recent years, is almost unparalleled in the history of agricultural development, can be

changed by suggestions based on laboratory investigations alone. Something more convincing is required.

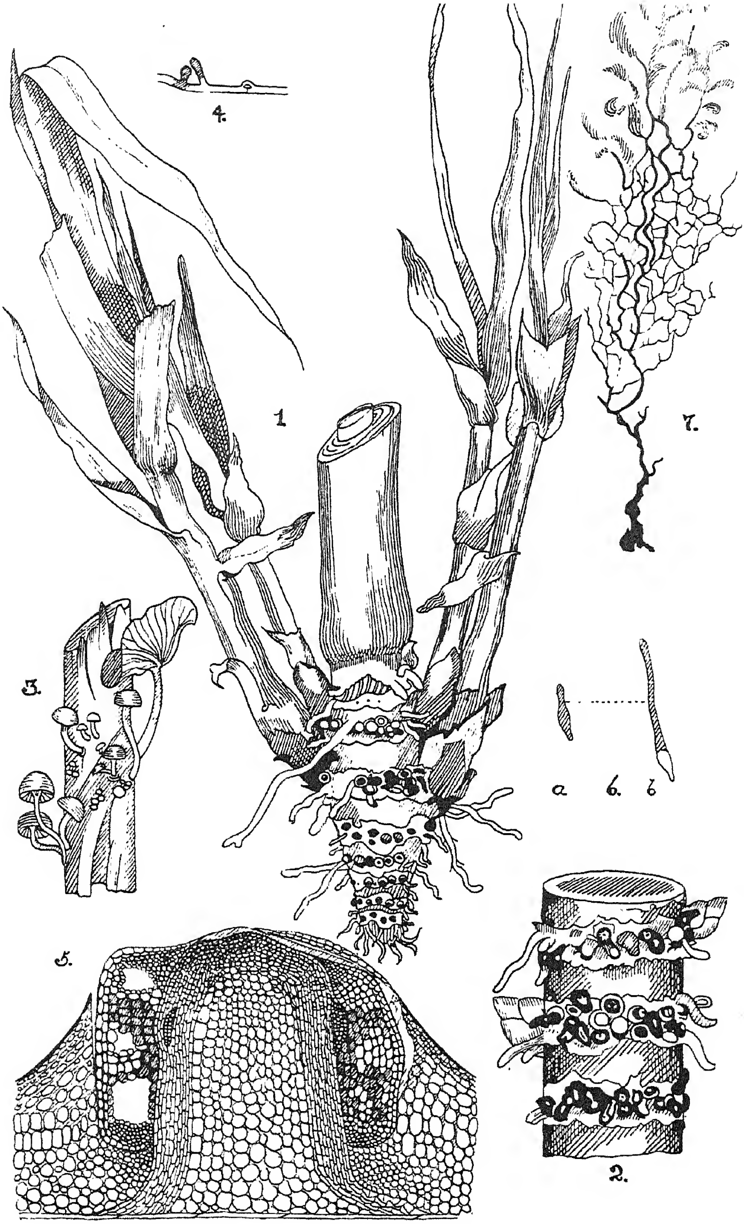
1. *The use of the best cuttings as plant material.*—It is a frequent practice in Barbados to select second crop canes attacked by this root disease for the preparation of cuttings, with the result that the fungus and the host are planted together. It would be interesting to compare the resulting canes with those derived from cuttings taken from the best canes. Possibly in addition to giving a better yield in the first crop the life of the stand might be increased in the latter case. In addition to this test it would be advisable to determine the economic value of protecting the cuttings by dipping them in Bordeaux mixture and tarring the cut ends or by dipping them in Bordeaux mixture alone.

2. *The cultivation of ratoons.*—The fact that it is during the early part of the life of the ratoon crop that the fungus is able to do so much damage suggests reaping fields destined for ratoons as late as possible and cultivating the ground round the old stumps so as to promote root development during the early rains. The only draw-back to this seems to be the danger of the old stumps being injured by drought. The matter, however, would appear to be worthy of trial.

3. *Starving the fungus in diseased fields.*—The most practicable way of doing this in Barbados would seem to be by throwing out the diseased field, removing and destroying the old cane stumps and planting rotation crops. How long the land should be kept free from canes can only be determined by experiment. Perhaps two rotation crops are necessary before the fungus disappears. In Surinam, an ingenious method of starving out the fungus in badly infected fields was adopted with success by the late Mr. James Mavor. After reaping, the old stumps were destroyed and the field placed under water for a year or two during which the fungus disappeared. After-wards the water was run off, the soil allowed to dry and a new crop of canes raised. The soil on this estate is a heavy clay and in spite of all precautions the fungus makes its appearance in the fields after they have been in canes for four or five years.

4. *Isolation of diseased areas.*—The occurrence of root-like strands (rhizomorphs) in connection with the fungus *Marasmius*, and the fact that the diseased areas are more or less circular in shape suggests that the fungus travels underground and that it would be desirable to cut off both diseased areas and diseased fields from the rest of the canes by a suitable trench.

5. *Disease-resisting varieties.*—It is quite common to see a few clumps of healthy canes in otherwise badly diseased fields. This suggests the possibility of selecting these for propagation and of



A ROOT DISEASE OF THE SUGAR CANE IN BARBADOS.

eventually raising disease-resisting strains. It would be further interesting to note the relative immunity of existing varieties by planting them in rows in diseased fields when the fungus abounds. Possibly some of them would be affected by the disease much less than others.

6. *The adoption of surface cultivation instead of mulching with cane trash during the dry season.*—The practice of strewing cane leaves on the ground around the young canes during the dry season is fairly general in Barbados. By this means moisture is conserved in the soil and the effect of the drought minimised. There would seem to be a danger however of spreading the root disease by this practice unless great care is taken in selecting the cane leaves. Further, more food material is available in the surface soil on which the fungus can live. If this is the case the comparative effect of trashing and surface cultivation becomes a question for experiment. Valuable as organic matter is in a soil like that of Barbados, it is conceivable that harm may be done by the addition of so much plant remains suitable for the growth of a fungus like *Marasmius.*

In conclusion I wish to express my indebtedness to the Editors of the *Annals of Botany* for their kind permission to use the figures which illustrate this paper and to Mr. E. T. Molecey, one of the students at Wye College, for the trouble he has taken in copying these drawings for reproduction in the present paper.

Summary of Conclusion.

1. The common root disease of the sugar-cane in Barbados is caused by the fungus *Marasmius Sacchari*, Wakker, the mycelium of which is able, under certain conditions, to overcome the growing point tissues of the developing roots of the cane.

2. No evidence of any connexion between the rind disease and this root disease was disclosed in these experiments. On the contrary, the whole of the results pointed to these diseases being distinct.

3. The directions in which experiments should be conducted, on an estate scale, to test the value of preventive measures, appear to be as follows :—

(*a.*) The use of the best cuttings for plant material.

(*b.*) The cultivation of ratoons during their early period of development.

(*c.*) Starving the fungus in diseased fields by suitable rotations.

(*d.*) The isolation of diseased areas.

(*e.*) The search for disease resisting varieties.

(*f.*) The comparison of surface cultivation and mulching with cane trash during the dry season.

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EXPLANATION OF PLATE.

FIG. 1.—A sugar cane stem attacked by the fungus *Marasmius Sacchari* showing the aborted roots and an abnormal development of the lower buds.

FIG. 2.—A portion of the below ground part of the stem of a similarly diseased cane showing the aborted roots on a larger scale.

FIG. 3.—A portion of the lower (above ground) part of the stem of a diseased sugar cane, showing colonies of the toadstools of *Marasmius Sacchari*.

FIG. 4.—A portion of the mycelium of *Marasmius*, showing a clamp-connexion and two thick-walled resting-spores.

FIG. 5.—Longitudinal section of a developing root of the sugar cane destroyed by the mycelium of *Marasmius*. The root cap is almost completely destroyed and the growing point and the shaded portions of the tissue of the root are filled with mycelium. The beginning of two lateral roots is also shown. × 35.

FIG. 6.—Stages in the germination of a spore of the fungus in a hanging drop. The sowing was made at 2 p.m. December 3rd.

$$\left.\begin{array}{l} a = \text{3-30 p.m. Dec. 3rd.} \\ b = \text{4-30 \ \ ,, \ \ \ \ \ \ ,,} \end{array}\right\} \times 375.$$

FIG. 7.—Production of rhizomorphs on the walls of a culture tube nine months after infection. Above, these bodies shade off into white feathery mycelial strands.

The importers of beet root sugar from Austria-Hungary are about to receive a large refund of the duties paid in India during the year which ended on the 31st July, 1902, the Government of India having ascertained that the additional duty charged has been in excess of the highest maximum paid by the Austria-Hungarian Government.

Dr. CLAASSEN'S PROCESS OF CRYSTALLISATION.

Crystallisation in motion, which some 15 years ago revolutionized more or less deeply our factory systems, has remained for too long a merely empirical process. Each individual made his own observations, which he interpreted after his own fashion, each had his particular recipé, each believed in having a method of his own; and nothing has gone further to prove the absence of a rational basis and certain principle in so important a process as the endless number of patents under the title of "crystallisation in motion," which have followed the initial lead of Bock.

What distinguishes Dr. Claassen from all other inventors in a similar task is largely the spirit which characterises his preliminary observations. Before his time, one knew doubtless that by means of slowly circulating the masse-cuite one would in practice facilitate the desugarizing of the syrups; but what was a more important and essential point, no one was in any way cognisant of principles of crystallisation. Dr. Claassen, who is both a skilled practitioner and a distinguished expert, undertook the study of this question, one of the most important to be met with now-a-days in the manufacture, on scientific lines, and in imposing on himself the task of inventing a special system of crystallisation, he proposed nothing less than the replacing by a veritable science, the difficult "Art of Boiling," the last remnant of routine which has still managed to keep its prestige in the rational domains of modern sugar technology.

The crystallisation of sugar like that of all other crystallisable substances is due to the supersaturated condition of a sugar solution. Analysing the mother syrup of a first strike at different moments of the boiling process, Dr. Claassen found that the degree of supersaturation of the running is in practice far from being constant, even with a good boiler. If we allow for the runnings of a first strike the same coefficient of solubility of sugar as for solutions of pure sugar, a hypothesis permitted *a priori* because it confirms to some observations of Herzfeld, and if we define as the coefficient of supersaturation the quotient found by dividing the figure which indicates the proportion of sugar dissolved in one part of water from the runnings by the number of parts of sugar held in solution by one part of water in a solution of pure sugar, this coefficient of supersaturation of the mother syrup varies for the same period of graining from 1·2 to 1·6; it averages 1·15 to 1·20 immediately before the period when charges are passed in by the pan-boiler; these latter dilute the syrup of the masse-cuite to a mean supersaturation of 1·05. With a good boiler in charge, the coefficient of supersaturation comprises just before the charging all the values between 1·0 and 1·3 according to the more or less rapid pace of boiling. Contrary to what one would be led to expect, it is not the highest coefficient which produces the greatest

desugarizing of the syrup. Besides provoking the disagreeable formation of fine grain, it frequently even retards the crystallisation of the existing grain.

It is thus that the results of Dr. Claassen's researches on the crystallisation of sugar have led him on to the study of the physical causes which place obstacles in the way of crystallisation, otherwise spoken of as the viscosity of the runnings. There also his experiments have thrown definite light on several very important points. In the first place, the sometimes considerable difference established in the respective viscous properties of different elements of non-sugar show that it is not always immaterial whether one makes use of lime, carbonate of soda, or caustic potash, for alkalising or neutralising the sugar products destined for crystallisation; and on the other hand, his tests prove that the much extolled advantages, from the point of view of crystallisation, of working with neutral or acid solutions, are too much exaggerated; and the same remark applies to certain so-called special processes intended to diminish the viscosity of syrups and runnings, for example by deplacing organic acids and their saline combinations by sulphuric acid, as in one of the Ranson processes. But of far greater importance than these negative results is the determination of the rôle played by the temperature on the viscosity of sugar solutions in general. The temperature is in fact for a given viscous substance, the principal, or even sole, cause of its viscosity; we know for example that a very concentrated molasses should become almost solid at a temperature of 10° C., and possess at 100° almost the fluidity of water. But on the other hand, the viscosity is not directly proportional to the temperature; in a system of co-ordinates where the abscisses represent the time which the solution takes in flowing out of the viscometer and where the temperatures of the tests are represented by the ordinates, one obtains in this case a strongly marked curve, more or less horizontal for a temperature of 10° to 35°, and inclining to the vertical towards 70-80° C. There is therefore nothing astonishing in the fact that at high temperatures above 70-80° the slightest differences in the respective viscosities of sugar solutions of various compositions are noticeable, pure saturated solutions and more or less impure supersaturated solutions containing a variable percentage of non-sugar. Beyond 75° C. the differences caused by the supersaturation or by the impurity of solutions are much accentuated, and it is important to take note of these different influences. Certain potash salts (nitrate and chloride) diminish in an exceptional way the viscosity of a pure saturated solution; as a general rule for the same acids, salts of soda increase the viscosity more than salts of potash, and salts of lime more than salts of soda. As compared with most of the salts, the free alkalis, and above all the carbonates, with the exception of potash carbonate, possess the properties of effecting the viscosity which are simply enormous.

It is here only a question of the increase in the viscosity of the sugar solutions due to the presence of salts dissolved with the sugar, the aqueous solution of salts alone scarcely differing from water in this respect. The non-sugar of molasses, thanks no doubt to the special viscous properties of soluble carbonates and free alkalis, possesses a greater "viscosigenous" power than the average of the other salts which enter into its composition. But what is of more interest is the actual influence of the degree of supersaturation on the sugar solutions. A solution of pure sugar possessing at a temperature of 30° a coefficient of supersaturation of 1·15, *i.e.*, a pure solution saturated at 30° in which one has dissolved about as much sugar as 10% of the solution, is sensibly more viscous than the same saturated solution of pure sugar in which one has dissolved 10% of non-sugar of molasses. The substance which yields the greatest obstacle to the crystallisation of a supersaturated running is thus the sugar and not the non-sugar. What is the good, then, of taking so much trouble to treat or maltreat the runnings under the pretext of diminishing the viscosity and thus increasing their yield in crystallised sugar, if in practice, as we have seen it happen, the variations in supersaturation to which the mother syrups in the boiling apparatus are exposed, even under the supervision of an increased pan-boiler, are able to provoke a redoubling of the viscosity much more important than the slight hypothetical diminution obtained by the treatment of the runnings? What confirms indirectly this point of view is the small difference observed in practice in the viscosity of a number of different molasses of German or Belgian origin; the greatest variations in viscosity produced by the varying composition of non-sugar from molasses does not correspond to the increase in viscosity caused by increasing the coefficient of saturation by 0·04 or 2·5% in sugar of a solution saturated at 30.

The chief consideration which ought to govern all rational methods of crystallisation is thus the diminution of the viscosity of mother syrups, and the most efficacious and only practical method for attaining this object is, apart from the observation of a suitable temperature, the maintenance of a feeble supersaturation.

But in order to estimate the degree of supersaturation of the runnings, it is necessary to ascertain decisively beforehand their relation to saturation; *i.e.*, how many parts of sugar they hold in solution for one part of water at a given temperature. For it is not certain that the relation of saturation of pure solutions, such as are given us in the well-known tables of Herzfeld (which we might at once, without running the risk of making a serious mistake, have applied to runnings having a quotient of purity above 75°) is correct for runnings of a lower purity. Dr. Claassen draws attention to what he himself calls "coefficient of saturation of the runnings"; in other words, the relation of the quantity of the sugar held in solution in a

really saturated running to that which contains a pure solution at the same temperature and for the same proportion of water. If $C =$ coefficient of saturation, $S_t =$ sugar dissolved in the pure saturated solutions at the temperature t, $S =$ quantity of sugar held in solution by one part of water at the same temperature in a certain running, and $C_t =$ coefficient of supersaturation, we shall have for the runnings $C_t = \frac{S}{S_t C}$ instead of $C = \frac{S}{S_t}$ for the pure solution.

Dr. Claassen ascertained in the first place certain coefficients of saturation for molasses, or analogous products, at temperatures which prevail in general in the crystallizers towards the end of the crystallisation. Other experts have drawn the samè deductions in this matter, but the principal achievement must be accorded to a Russian, M. Schukow. The latter showed by conclusive evidence the variability in the power of producing molasses possessed by different salts and by the non-sugar of beet juice in various doses and temperatures, which all goes to complicate the question of the coefficient of saturation of runnings. The power of producing molasses possessed by salts and non-sugar increases very much with the temperature, whilst a feeble dose, in the case of runnings of high purity and at low temperatures, salts and non-sugar, actually exercises a desugarising action. The coefficient of saturation is then less than 1. The results of Mr. Schukow's experiment were very valuable in so far as they showed the influence of the purity and of the temperature on the coefficient of saturation of the runnings; nevertheless these experiments, when we desire to deduce the coefficient of saturation of the runnings, give no universally accurate information, that is to say, always confirmed by practice; and it is by special tests, which are unfortunately not yet made public, that Dr. Claassen himself determined these coefficients with runnings of different purities and at different temperatures which are in the end the scientific basis of his process of crystallisation.

The influence of the temperature on the saturation of runnings is such that the coefficient of saturation of one of 60 purity, while about 1·2 near 45°C., increases to 1·6 at about 70°; that of runnings of 65 purity rises from 1·05 about 45° to 1·4 towards 70°.

All these theories are so to say but the necessary preparation for the right understanding of Dr. Claassen's method of crystallisation. We can however deduce therefrom in advance what it will be and show in a few words what the principle is. The conditions of a perfect crystallisation consist in the maintenance as evenly as possible of that degree of supersaturation deemed by long experience to be the most advantageous.

The first practical consequence which results from this rule is the necessity of being able to indicate at any moment the proportion of water in the masse-cuite in process of formation or still more of the

mother syrup in that masse-cuite. It is with that object that Dr. Claassen has invented his apparatus for controlling the boiling, similar to the idea contained in the brasmoscope of Curin, but possessing the great advantage over it of indicating directly the percentage in water of the mother syrup. Knowing the boiling point for different degrees of vacuum, and the increase in the boiling point caused for a given temperature by syrups of varying composition, it is easy by means of a simple set of rules and tables, based on the readings of the thermometer and manometer, to find out the degree of concentration of the mother syrup which is boiling in the pan. And, on the other hand, given a certain vacuum, so as to obtain in the syrup a known proportion of water, it only remains to see that the corresponding temperature is maintained.

The scale of increase in temperature of boiling the runnings of different purities and different concentrations, which constitutes the principal part of this controlling apparatus is indeed the personal scientific work of Dr. Claassen's. By its means the task of the boiler becomes as simple as that of the carbonateur is owing to the existence of the titrating burette; for a table arranged specially for this work and forming part of the apparatus defines for him beforehand the proportion of water which he will notice at different moments of the boiling, thus enabling him to carry on the latter under the most favourable conditions for crystallisation.

Dr. Claassen has from the first applied his method to the boiling to grain of first strike runnings; and, therefore, though certainly destined to a great extension, it is at present known under the name of "process of crystallisation of after-products."

One cannot deny that this task is not one of the most difficult parts of the manufacture when one proposes to obtain with a minimum of cost and trouble from an after-product masse-cuite a sugar of fine grain which will not need to be remelted for working up in a refinery, and a well-purified molasses syrup. The table for the controlling apparatus destined to regulate the degree of supersaturation is thus arranged specially for the boiling to grain of the runnings. It is as follows:—

Yield in Water Percentage of Mother Syrup.

Temp. of boiling.	When graining, the purity of the running being 80. a.	77½. b.	75. c.	72½. d.	70. e.
70	17¼	16¼	15¼	14½	13¼
75	16½	15½	14½	13¾	12½
80	15½	14¾	13¾	13	12
85	14¾	14	13	12¼	11¼
90	13¾	13	12¼	11½	10½
95	13	12	11½	10¾	9¾
100	—	—	—	—	—

Temp. of boiling.	During the boiling. 1st Pan. *f*.	2nd Pan. *g*.	3rd Pan. *h*.	For the final contraction. *i*.
70	12½	12	11½	11
75	12	11½	11	10½
80	11½	11	10½	9¾
85	11	10½	10	9¼
90	10½	10	9½	8¾
95	9½	9	8½	8
100	—	—	—	7½

The coefficients of supersaturation which have served as the basis of calculation of the figures indicating the percentage of water in the mother syrup for graining are as follows:—

Purity of the running	80	76	70
Coefficient of supersaturation	1·20	1·26	1·25

For a purity of 82½ the same coefficient is lowered to 1·15; it is at 1·35 for a purity of 67½. It is therefore evident that these coefficients are a long way from those observed in fact, during the graining of the syrup of 90-92 of purity without the aid of a controlling apparatus. Similarly, during the whole period of crystallisation in the boiling pan, the coefficients retain a relatively feeble value.

(To be continued.)

THE SUGAR CANE IN EGYPT.

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(Continued from page 243.)

Field Experiments, 1897—1900.

About the middle of the nineties a desire was expressed on the part of both planters and factories in Egypt for a decided improvement in, and a rational management of, the sugar cane cultivation. Following on disagreeable incidents between the factories and the landowners, a private company founded the agricultural station at Cheik Fadl (Upper Egypt) with a view to controlling the cane supply and improving the culture. In 1897 a beginning was made with the field experiments, which, however, served merely as a kind of preliminary examination to indicate the special lines to be followed. These field experiments are given below in the order of their years. The results show distinctly that one is in a position by means of improved planting methods, intelligent selection of planting material, and in particular by good manuring, to obtain a much higher (in some cases double)

crop result as well as land rent, than the Egyptian fellah achieves with his customary indifferent cultivation.

The planting of the 1897 experiment fields began on March 14th. For plant material first year cane from an adjacent field was selected. The analysis of these canes gave

Sp. Gr.	Brix	Per cent. Sugar in Juice	Non-Sugar	Quotient	Per cent. Sugar in Cane	Per cent. Glucose
1·080 ..	19·2 ..	16·88 ..	2·3 ..	87·9 ..	14·5 ..	0·18

Average length of Canes, 6 ft.
,, weight of Canes, 1,190 gr.
,, ,, Leaves, 275 gr.

The plant cane was cut up into pieces containing three nodes, and in every parcel for each plant row a fixed number of cuttings were carefully counted off. In each parcel again the treble-noded cuttings destined for a particular row were carefully shuffled, so as to obtain perfectly even conditions; this kind of treatment naturally extended over the whole duration of the vegetation, so that at the subsequent conclusion of the experiment accurate figures of comparison could be obtained, enabling all the results to be compared under perfectly fair conditions. As regards the remaining needful work of watering, hoeing, &c., it was considered advisable to follow the usual local method, so as not to needlessly complicate the analysis of the early experiments.

Manurial Experiments, 1897.

(First year canes.)

Manure Applied per Hectare.

No.
0. Unmanured cuttings taken from the whole cane stem.
1. ,, ,, ,, top part of ,,
2. 200 kg*. Chile saltpetre.
3. 400 ,, ,, ,,
4. 200 ,, ,, ,, and 400 kg. superphosphate.
5. 200 ,, ,, ,, ,, 200 ,, sulphate of potash.
6. 200 ,, ,, ,, ,, 200 ,, ,, ,, and 400 kg. superphosphate.
7. 200 ,, Chile saltpetre, 200 kg. sulphate of potash, 400 kg. superphosphate, and 2,400 kg. lime.
8. 400 ,, Chile saltpetre, 200 kg. sulphate of potash, 400 kg. superphosphate, and 2,400 kg. lime.
9. Unmanured, with cuttings taken from middle portion of cane stem.

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*200 kilo per hectar = 180 lbs. per acre.
400 ,, ,, = 360 lbs. ,,
2,400 ,, ,, = 2,160 lbs. ,,

10. 200 kg. superphosphate.
11. 400 ,, ,,
12. 400 ,, ,, and 200 kg. sulphate of potash.
13. 400 ,, ,, ,, 200 ,, ,, ,, and 200 kg. saltpetre.
14. 400 ,, superphosphate, and 400 kg. sulphate of potash, and 200 kg. saltpetre.
15. 400 ,, superphosphate, and 400 kg. sulphate of potash, and 200 kg. saltpetre, and 2,400 kg. lime.
16. 400 ,, superphosphate, and 200 kg. sulphate of ammonia.
17. 400 ,, ,, ,, 400 ,, ,, ,,
18. 400 ,, ,, ,, 400 ,, ,, ,, and 2,400 kg. lime.
19. 400 ,, sulphate of ammonia, and 2,400 kg. lime.
20. 200 ,, magnes.-ammonium sulphate, 200 kg. saltpetre, and 400 kg. superphosphate.
21. 400 ,, magnes.-ammonium sulphate, 200 kg. saltpetre, and 400 kg. superphosphate.
22. 800 ,, magnes.-ammonium sulphate, 200 kg. saltpetre, and 400 kg. superphosphate.
23. 200 ,, magnes.-ammonium sulphate, 200 kg. saltpetre, 400 kg. superphosphate, and 2,400 kg. lime.
24. 2,400 kg. lime.
25. 4,000 ,, ,,
26. Unmanured, with cuttings taken from lowest part of cane stem.

CROP YIELDS IN THE 1897 EXPERIMENTS (FIRST YEAR CANES).

Number.	Kilos Cane per Hectare.	Cantars Cane per Feddan.	lbs. per acre.
0	61328	572	54689
1	72960	681	65062
2	75296	703	67145
3	76656	715	68358
4	71616	668	63864
5	79920	741	71269
6	84640	789	75478
7	72480	676	64634
8	74400	690	66346
9	69472	648	61952
10	75584	705	67402
11	57025	532	50852
12	61344	572	54704
13	73744	688	65761
14	76016	709	67787
15	73360	684	65419
16	74768	697	66674
17	69104	644	61624
18	80160	748	71483
19	70400	657	62779
20	68480	629	61067
21	70860	661	63189
22	65168	608	58114
23	67312	628	60026
24	66112	617	58955
25	64432	601	57457
26	55504	508	49496

ANALYSIS OF YIELDS IN FIELD EXPERIMENTS (1897).

No.	Sp. Gr.	Br.	Bé.	Per cent. juice.	Non Sugar.	Quotient.	Per cent. Sugar in Cane.	Per cent. Glucose.	Average weight per cane stem gr.
0	1·062	15·2	8·6	12·4	2·8	81·5	10·5	1·3	1062
1	1·070	17·0	9·5	14·44	2·5	84·9	11·9	1·1	1164
2	1·064	15·7	8·9	13·36	2·3	84·4	10·9	1·2	1395
3	1·066	16·1	9·1	13·26	2·8	82·3	11·2	1·1	1260
4	1·061	14·9	8·4	12·26	2·6	82·3	11·0	1·1	1250
5	1·061	15·0	8·5	12·4	2·6	82·1	10·8	1·2	1280
6	1·062	15·1	8·5	12·75	2·3	83·4	10·8	1·2	890
7	1·061	14·9	8·4	12·48	2·4	83·7	11·0	1·1	1255
8	1·061	15·0	8·5	12·94	2·0	86·0	11·4	1·1	1290
9	1·067	16·2	9·2	13·92	2·2	85·9	12·0	0·7	1280
10	1·062	15·2	8·6	12·72	2·4	83·6	11·4	0·7	1240
11	1·067	16·4	9·3	13·93	2·4	84·9	11·1	1·1	945
12	1·065	15·9	9·0	13·42	2·4	84·4	11·6	1·0	1095
13	1·062	15·2	8·6	12·8	2·4	84·2	11·1	0 8	1300
14	1·062	15·2	8·6	13·18	2·0	86·6	11·5	0·7	1273
15	1·064	15·7	8·9	13·09	2·6	83·2	11·4	1·2	1100
16	1·064	15·7	8·9	12·99	2·7	82·7	11·0	1·1	1082
17	1·063	15·5	8·8	13·45	2·0	86·7	11·3	1·1	873
18	1·060	14·8	8·4	12·67	2·1	88·6	11·2	0·9	970
19	1·062	15·2	8·6	12·64	2·5	83·1	11·3	0·8	1223
20	1·059	14·4	8·2	12·15	2·2	84·3	10·6	1·2	1168
21	1·063	15·3	8·6	12·69	2·6	82·9	11·6	0·9	1200
22	1·064	15·7	8·9	13·15	2·5	83·7	11·9	0·9	1260
23	1·063	15·3	8·6	12·99	2·3	84·9	11·4	1·1	1080
24	1·063	15·3	8·6	12·91	2·3	84·3	11·3	0·7	12·85
25	1·062	15·1	8·5	12·72	2·3	84·2	11·1	0·8	975
26	1·060	14·7	8·3	12·42	2·2	84·4	10·6	1·1	1150

The course of the 1897 experiments was as follows: owing to unfavourable weather conditions the canes did not develop full maturity. Violent storms in September, followed by almost equally strong ones in November, laid low more or less of the eight months' old cane, and in the first few days of December a sharp hoar frost put in an appearance. This frost (being of a kind which, while unexpected, lasts but a night or two, and is accompanied by a north wind) attacks all cane fields not protected by adjacent hills, affecting the canes in the tenderest top portions where the youngest leaves branch out from the stem. On subsequently examining the field and dividing lengthways a sample cane top, a more or less distinct brown colouring is found in the tenderest top portion as a result of the frost. Under these circumstances the green leaves soon wither; the process of ripening and sugar formation stops, the sugar content, on the contrary, deteriorates, decomposes, and ferments on the field, as the fluctuations of temperature between day and night frequently amount

to as much as from 25° to 30°C. Whereas for example, the average figures for sugar content during the campaign of the preceding year 1896-97 came to 14·0%, in 1897-98 it only reached 11%. The 1897 experiment fields naturally did not escape unscathed, and were equally affected by the strong storms and the frost.

The germination and raising of the cuttings progressed in a regular manner. After a short while it could be seen that the unmanured plots were slower in developing, with the exception of the top cuttings which equalled the manured cane in colour and growth. The best results were attained by plot No. 5, manured with nitrogen and potash.

If we first consider experiments 0, 1, 9, 26 (without manure), then the difference in the figures of yield is very striking. The lowest portion of planted cane stem No. 26 yielded the poorest results for a given area, the top portion the best. The top part yielded an excess of 3,500 kg. cane over that of the middle part, and 17,500 kg. cane over the lowest part per hectare when no manure was applied. This confirms fully the supposition arising out of the experiments. It is not correct to plant out the richest portions of the lower stem (as was erroneously recommended to the planters by the French sugar factories), but on the contrary one should select the most germinative part of the stem that is richest in sugar. The young upper part of the stem, owing to the collecting of the juice in it, has physiologically a greater vitality than the middle or lower parts. The stem nodes are still fresh and develop germination more quickly and powerfully to begin with, and this has its influence on the whole subsequent period of growth. The experiments show distinctly that the upper portions of the cane must be employed for planting out.

The different selected artificial manures could not, owing to the injury caused by the above-mentioned storms and frosts, obtain full scope for their action, and it is therefore impossible to draw definite results from the 1897 experiments. If we calculate the amounts of sugar obtained for a given area arising out of these experiments, then we have the following summary:—

Amounts of sugar obtained per hectare and acre in connection with the 1897 Field Experiments with First Year Cane (a frost year).

No.		Kilo. of Sugar per hectar.	*Lbs. of Sugar per acre.
0	Without manure. With whole canes as cuttings ..	6513 ..	5808
1	,, ,, ,, treble-noded ,, ..	8756 .	7909
2	With saltpetre	8252 ..	7358
3	,, ,, ...	8248 ..	7355
4	,, ,, and superphosphate	7376 ..	6577

* 1lb. = 0·454 kilos. 1 kilo. = 2·2026lbs. 1 hectar = 2·47 acre.

No.		Kilo. of Sugar per hectar.	Lbs of Sugar per acre.
5	With saltpetre and sulphate of potash	8335 ..	7432
6	,, ,, ,, ,, ,, and superphos.	8827 ..	7871
7	Saltpetre, sulphate of potash, superphos. and lime.	7618 ..	6793
8	,, ,, ,, ,, ,, ..	8126 ..	7246
9	Without manure. Cuttings from middle of stem..	7493 ..	6681
10	With superphosphate	7687 ..	6854
11	,, ,, ...	6270 ..	5591
12	,, ,, and sulphate of potash ..	6870 ..	6126
13	,, ,, ,, ,, & saltpetre	7957 ..	7095
14	,, ,, ,, ,, ,, ..	7830 ..	6982
15	,, ,, and lime	7563 ..	6744
16	Sulphate of ammonia and superphosphate	8132 ..	7251
17	,, ,, ,, ...	7665 ..	6835
18	,, ,, ,, and lime.	8657 ..	7711
19	,, ,, and lime..	7568 ..	6749
20	Potash magnesia and saltpetre and superphosphate	7252 ..	6467
21	,, ,, ,, ,, ..	7370 ..	6572
22	,, ,, ,, ,, ..	7283 ..	6494
23	,, ,, ,, ,, ..	7377 ..	6579
24	Lime	7933 ..	7074
25	Lime	7332 ..	6538
26	Unmanured; lowest cuttings	6017 ..	5365

From the foregoing tables we may draw the following conclusions:—

No. 0 served as a test plot and without manure yielded a crop of 61 metric tons of cane per hectare = 24·7 tons of cane per acre; or 6·5 metric tons sugar per hectare = 2·6 tons of sugar per acre.

Adjacent to these stood fully manured plots, Nos. 6, 7, 8, 13 and 14, with an average yield of 76 metric tons cane, the maximum being 84·6 tons per hectare = 30·7 to 34·2 tons cane per acre; or 8 metric tons sugar, the maximum being 8·8 tons per hectare = 3·2 to 3·5 tons sugar per acre.

The potash and nitrogen plots (2 to 8) with an average yield of 76·4 metric tons cane per hectare = 30·9 tons of cane per acre; or 8·1 metric tons sugar = 3·2 tons sugar per acre were superior to the ammonia-nitrogen plots (Nos. 16 to 19) which averaged 70·6 metric tons cane per hectare = 28·5 tons of cane per acre; or 8·0 metric tons sugar = 3·2 tons sugar per acre.

The superphosphate plots (10 to 15) averaged 69·5 metric tons cane per hectare = 28·1 tons of cane per acre; 7·3 metric tons sugar per hectare = 2·9 tons sugar per acre.

With superphosphate alone the manured is not better than the unmanured. With the addition, however, of nitrogen, there is an increase in the yield (Nos. 13, 14).

The results were not particularly controllable in the case of the manuring with potash of canes remaining unripe, perhaps in the fully manured plots with N and P_2O_5 in spite of the fact that potash is one of the most important plant nutriments, especially for the sugar cane, and was observed to be working well on the potash plots (Nos. 5 to 8 and 12 to 15) during their growth.

Large doles of magnesium potash had no result, no more than large applications of lime. All the observations and experiments made led to the conclusion that nitrogenous manuring in the given proportions had the greatest apparent influence on the cane in Upper Egypt. In determining between saltpetre and ammonium nitrate one had better give preference to the former as well on financial as on technical grounds. From different experiments the writer found it most important for canes, and other cultures too, that the saltpetre should in every case be given just after a watering. One should sprinkle the saltpetre in measured quantities (mixed with sandy soil) along the plant rows as soon as the irrigation water has had one or two days to settle. Then the saltpetre is enabled to act to its fullest capacity and when on the expiration of a fortnight, a fresh watering takes place, it will not be further dissolved or washed away, because it will then have been absorbed by the plants.

In the foregoing the writer has given all the particulars that were to be derived from the 1897 experiments. The analyses and the crop figures in this exceptional year gave no definite grounds for forming a judgment, and therefore must be accepted with every reserve. Possibly they may prove serviceable for purposes of comparison with later years, yet in spite of the failure of the trials, observations made during the vegetation enabled one to see that the sugar cane and the soil of the Nile Valley are particularly capable of absorbing mineral manures, and that this produces a large increase in the crop as compared with unmanured cane.

II. Field Manuring Experiments with Sugar Cane, 1898.

(*a*) *First Year Canes.*

In the year 1898 field experiments were undertaken on first and second year canes. Owing to the planting falling in the time of the campaign work, and the station being fully occupied in controlling the cane deliveries so as to sort out the frost-bitten and rotten canes, only a few experiments in fresh planting were possible.

The area of the experiment field of 1898 first year cane amounted to 3,515 square metres and was divided into three oblong plots. The method and planting employed was different this time. The use of top cuttings was out of question, because nearly all the cane was more or less touched by frost and the bud eyes on the top stems thereby killed. A selection of plant material was made in this wise: From the best conditioned fields such as were planted the

previous year with top cuttings the strongest, best developed canes were chosen for cuttings.

In Plot No. 1 the selected canes were planted in rows 1 metre apart.

In Plot No. 2 the cane, also selected, was planted in rows 1·20 metres apart.

In Plot No. 3 the cane (unselected) was planted according to the customary Arab method.

The manures employed were distributed as follows :—

PLOT NO. 1. (1,000 sq. metres).	PLOT NO. 2. (1,000 sq. metres).	PLOT NO. 3. (1,515 sq. metres).
30 kg. Saltpetre	30 kg. Saltpetre	*No Manures.*
50 kg. Thomas slag	50 kg. Thomas phosphate	
75 kg. Molasses ash	75 kg. Molasses ash	

Nos. 1 and 2 were thus equally manured, while No. 3 remained unmanured. By means of this demonstrative experiment the results of full manuring and selection, as compared with unmanured Arabic methods, were looked forward to, and were distinctly shown in the subsequent crop yields. These field tests under equal treatment took a normal course during the whole period of vegetation. The arrangement of wider planting intervals, 1 metre with "single" and 1·20 with "double" rows of cuttings, was distinctly superior to the Arabic arrangement with intervals of only 0·70 metre. The sugar contents of these three parcels was most satisfactory, and showed that the canes grown from carefully-selected cuttings, and treated with manures (Nos. 1 and 2), gave better results than No. 3. The quantitative yields were as follows :—

CROP YIELDS OF 1898 EXPERIMENTS (*First Year Canes*).

No.	Kg. Canes. per hectare.	Cantars Cane per feddan.	Lbs. per Acre.
1	79,546	742	70,935
2	83,132	775	74,133
3	56,937	531	50,774

ANALYSES OF RESULTS FROM 1898 EXPERIMENTS (*First Year Canes*).

	1	2	3
Sp. Gr.	1·072	1·072	1·068
Brix	17·4	17·4	16·5
Baumé	9·8	9·8	9·3
Sugar in Juice	14·41	14·67	13·47
Non-sugar	2·9	2·7	3·0
Quotient	82·8	84·3	81·1
Sugar in Cane	12·4	12·5	11·7
Glucose	0·6	0·6	0·8
Average weight per cane stem	1,418 gr.	1,408 gr.	1,346 gr.

(b) Second Year Canes.

For the proposed experiments with second year canes, the observations and results of the 1897 field experiments were taken into consideration; in particular, the established influence of nitrogenous manuring. Moreover, the general appearance, the pale-lead colour of the leaves of the second year plants in nearly all fields betokened a want of nitrogen. Consequently, the 27 plots of 1897 first year canes were used with the same division for the 1898 second year experiments, and besides that, the two chief nitrogenous manures, saltpetre and sulphate of ammonia, were employed in contradistinction to the otherwise needed customary native manuring mediums. All 27 plots obviously received the same handling save as to manures. The loosening of the soil between plant rows and the heaps was done by ploughs. This work, undertaken with care—that is, guiding the animal straight—being found ever so much better and more advantageous than hand work with the hoe. The individual plots were manured as follows:—

Field Manurial Experiments, 1898 (Second year canes).

27 plots of 625 sq. metres.

No.

0., 1., 2. Unmanured.

3 to 8. Dove guano, 3 ardebs.

9. Unmanured.

10., 11. Saltpetre: 200 kgr. per hectare = 180 lbs. per acre.

12., 13. Saltpetre: 400 kgr. per hectare = 360 lbs. per acre.

14 to 17. Old ruins manure (zebach adim) 16 cubic metres per hectare.

18 to 21. Sulphate of ammonia $(NH_4)_2SO_4$, 400 kg. per hectare = 360 lbs. per acre.

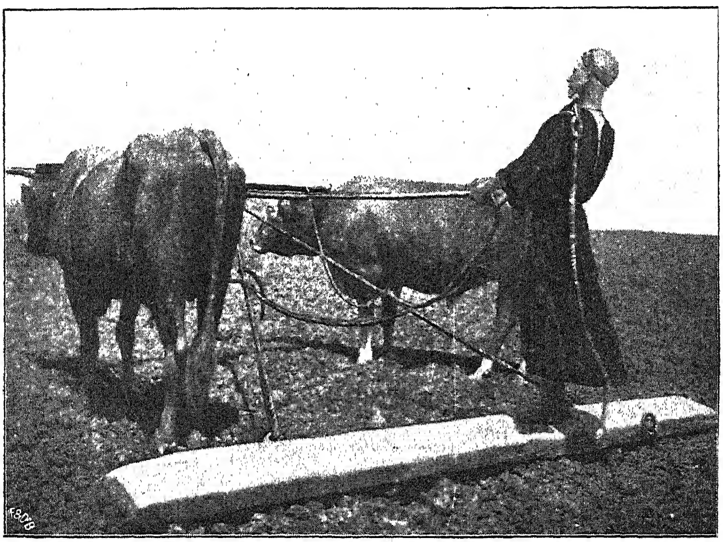
22 to 26. Unmanured.

An analysis of the manuring mediums employed gave the following proportions of plant nutriment:—

	Nitrogen. Per cent.	P_2O_5 Per cent.	K_2O Per cent.
Egyptian dove guano	4·2	1·9	2·8
Ruins manure	0·5	0·2	2·9
Saltpetre	15·5	—	—
Sulphate of ammonia	16·6	—	—

Dividing the plots according to the manures applied we obtain the following results:—

Ox Shovel for Levelling the Field.



Wooden Block used in place of Rollers to crush hard lumps, called "Kassára."

	Kilograms per hectare.	Cane. Cantars per fadden.	Lbs. per acre.
1. Unmanured—			
Nos. 0, 1, 2, 9, 22, 23, 24, 25, 26 ..	26,925 ..	251·2 ..	24,009
2. With Dove Guano—			
Nos. 3, 4, 5, 6, 7, 8	31,900 ..	295·0 ..	28,444
3. With Saltpetre—			
Nos. 10 and 11	44,708 ..	416·6 ..	39,861
4. With Saltpetre (double)—			
Nos. 12 and 13	55,156 ..	514·7 ..	49,185
5. With Sulphate of Ammonia $(NH_4)_2SO_4$—			
Nos. 18, 19, 20, 21	44,528 ..	415·5 .	39,700
6. Ruins Manures—			
Nos. 14, 15, 16, 17	29,150 ..	272·0 ..	25,991

Analysis of Field Experiments, 1898 (Second Year Cane).

Nos.	Averages.								Average weight per Cane Stem.
	Specific Gravity	Brix.	Baumé.	Sugar in Juice.	Non-Sugar.	Quotient.	Sugar in Cane.	Glucose	
0, 1, 2, 9, 22-26, Unmanured	1·081	19·4	10·9	16·69	2·7	85·9	14·1	0·4	526
3, 4, 5, 6, 7, 8, Dove guano.	1·079	19·0	10·7	16·12	2·9	84·5	14·0	0·3	602
10, 11, Saltpetre.	1·081	19·5	11·0	16·48	3·0	84·3	14·2	0·5	870
12, 13, Saltpetre (doubled).	1·079	19·0	10·7	16·21	2·7	85·3	13·9	0·5	858
18, 19, 20, 21, Sulphate of potash.	1·079	19·0	10·7	15·96	3·0	84·0	13·6	0·6	800
14, 15, 16, 17, Ruins manure.	1·078	18·7	10·5	15·95	2·8	84·9	13·7	0·6	519

A glance over the figures of yields of the above experiments shows distinctly enough the tolerably large difference between particular experiment rows. Considering the analysis of the natural manuring mediums hitherto employed in the country reveals so small a content in those plant nutriments which the sugar cane stands so absolutely in need of, it is only to be expected that a good result would be hard to obtain. The plots treated with dove guano (Nos. 3 to 8) show

Temp. of boiling.	During the boiling. 1st Pan. f.	2nd Pan. g.	3rd Pan. h.	For the final contraction. i.
70	$12\frac{1}{2}$	12	$11\frac{1}{2}$	11
75	12	$11\frac{1}{2}$	11	$10\frac{1}{2}$
80	$11\frac{1}{2}$	11	$10\frac{1}{2}$	$9\frac{3}{4}$
85	11	$10\frac{1}{2}$	10	$9\frac{1}{4}$
90	$10\frac{1}{2}$	10	$9\frac{1}{2}$	$8\frac{3}{4}$
95	$9\frac{1}{2}$	9	$8\frac{1}{2}$	8
100	—	—	—	$7\frac{1}{2}$

The coefficients of supersaturation which have served as the basis of calculation of the figures indicating the percentage of water in the mother syrup for graining are as follows:—

Purity of the running	80	76	70
Coefficient of supersaturation	1·20	1·26	1·25

For a purity of $82\frac{1}{2}$ the same coefficient is lowered to 1·15; it is at 1·35 for a purity of $67\frac{1}{2}$. It is therefore evident that these coefficients are a long way from those observed in fact, during the graining of the syrup of 90-92 of purity without the aid of a controlling apparatus. Similarly, during the whole period of crystallisation in the boiling pan, the coefficients retain a relatively feeble value.

(To be continued.)

THE SUGAR CANE IN EGYPT.

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(Continued from page 243.)

Field Experiments, 1897—1900.

About the middle of the nineties a desire was expressed on the part of both planters and factories in Egypt for a decided improvement in, and a rational management of, the sugar cane cultivation. Following on disagreeable incidents between the factories and the landowners, a private company founded the agricultural station at Cheik Fadl (Upper Egypt) with a view to controlling the cane supply and improving the culture. In 1897 a beginning was made with the field experiments, which, however, served merely as a kind of preliminary examination to indicate the special lines to be followed. These field experiments are given below in the order of their years. The results show distinctly that one is in a position by means of improved planting methods, intelligent selection of planting material, and in particular by good-manuring, to obtain a much higher (in some cases double)

crop result as well as land rent, than the Egyptian fellah achieves with his customary indifferent cultivation.

The planting of the 1897 experiment fields began on March 14th. For plant material first year cane from an adjacent field was selected. The analysis of these canes gave

Sp. Gr.	Brix	Per cent. Sugar in Juice	Non-Sugar	Quotient	Per cent. Sugar in Cane	Per cent. Glucose
1·080	19·2	16·88	2·3	87·9	14·5	0·18

Average length of Canes, 6 ft.
,, weight of Canes, 1,190 gr.
,, ,, Leaves, 275 gr.

The plant cane was cut up into pieces containing three nodes, and in every parcel for each plant row a fixed number of cuttings were carefully counted off. In each parcel again the treble-noded cuttings destined for a particular row were carefully shuffled, so as to obtain perfectly even conditions; this kind of treatment naturally extended over the whole duration of the vegetation, so that at the subsequent conclusion of the experiment accurate figures of comparison could be obtained, enabling all the results to be compared under perfectly fair conditions. As regards the remaining needful work of watering, hoeing, &c., it was considered advisable to follow the usual local method, so as not to needlessly complicate the analysis of the early experiments.

Manurial Experiments, 1897.

(First year canes.)

Manure Applied per Hectare.

No.

0. Unmanured cuttings taken from the whole cane stem.
1. ,, ,, ,, top part of ,,
2. 200 kg*. Chile saltpetre.
3. 400 ,, ,, ,,
4. 200 ,, ,, ,, and 400 kg. superphosphate.
5. 200 ,, ,, ,, ,, 200 ,, sulphate of potash.
6. 200 ,, ,, ,, ,, 200 ,, ,, ,, and 400 kg. superphosphate.
7. 200 ,, Chile saltpetre, 200 kg. sulphate of potash, 400 kg. superphosphate, and 2,400 kg. lime.
8. 400 ,, Chile saltpetre, 200 kg. sulphate of potash, 400 kg. superphosphate, and 2,400 kg. lime.
9. Unmanured, with cuttings taken from middle portion of cane stem.

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*200 kilo per hectar = 180 lbs. per acre.
400 ,, ,, = 360 lbs. ,,
2,400 ,, ,, = 2,160 lbs. ,,

10. 200 kg. superphosphate.
11. 400 ,, ,,
12. 400 ,, ,, and 200 kg. sulphate of potash.
13. 400 ,, ,, ,, 200 ,, ,, ,, and 200 kg. saltpetre.
14. 400 ,, superphosphate, and 400 kg. sulphate of potash, and 200 kg. saltpetre.
15. 400 ,, superphosphate, and 400 kg. sulphate of potash, and 200 kg. saltpetre, and 2,400 kg. lime.
16. 400 ,, superphosphate, and 200 kg. sulphate of ammonia.
17. 400 ,, ,, ,, 400 ,, ,, ,,
18. 400 ,, ,, ,, 400 ,, ,, ,, and 2,400 kg. lime.
19. 400 ,, sulphate of ammonia, and 2,400 kg. lime.
20. 200 ,, magnes.-ammonium sulphate, 200 kg. saltpetre, and 400 kg. superphosphate.
21. 400 ,, magnes.-ammonium sulphate, 200 kg. saltpetre, and 400 kg. superphosphate.
22. 800 ,, magnes.-ammonium sulphate, 200 kg. saltpetre, and 400 kg. superphosphate.
23. 200 ,, magnes.-ammonium sulphate, 200 kg. saltpetre, 400 kg. superphosphate, and 2,400 kg. lime.
24. 2,400 kg. lime.
25. 4,000 ,, ,,
26. Unmanured, with cuttings taken from lowest part of cane stem.

CROP YIELDS IN THE 1897 EXPERIMENTS (FIRST YEAR CANES).

Number.	Kilos Cane per Hectare.	Cantars Cane per Feddan.	lbs. per acre.	Number.	Kilos Cane per Hectare.	Cantars Cane per Feddan.	lbs. per acre.
0	61328	572	54689	14	76016	709	67787
1	72960	681	65062	15	73360	684	65419
2	75296	703	67145	16	74768	697	66674
3	76656	715	68358	17	69104	644	61624
4	71616	668	63864	18	80160	748	71483
5	79920	741	71269	19	70400	657	62779
6	84640	789	75478	20	68480	629	61067
7	72480	676	64634	21	70860	661	63189
8	74400	690	66346	22	65168	608	58114
9	69472	648	61952	23	67312	628	60026
10	75584	705	67402	24	66112	617	58955
11	57025	532	50852	25	64432	601	57457
12	61344	572	54704	26	55504	508	49496
13	73744	688	65761				

Analysis of Yields in Field Experiments (1897).

No.	Sp. Gr.	Br.	Bé.	Per cent. juice.	Non Sugar.	Quotient.	Per cent. Sugar in Cane.	Per cent. Glucose.	Average weight per cane stem gr.
0	1·062	15·2	8·6	12·4	2·8	81·5	10·5	1·3	1062
1	1·070	17·0	9·5	14·44	2·5	84·9	11·9	1·1	1164
2	1·064	15·7	8·9	13·36	2·3	84·4	10·9	1·2	1395
3	1·066	16·1	9·1	13·26	2·8	82·3	11·2	1·1	1260
4	1·061	14·9	8·4	12·26	2·6	82·3	11·0	1·1	1250
5	1·061	15·0	8·5	12·4	2·6	82·1	10·8	1·2	1280
6	1·062	15·1	8·5	12·75	2·3	83·4	10·8	1·2	890
7	1·061	14·9	8·4	12·48	2·4	83·7	11·0	1·1	1255
8	1·061	15·0	8·5	12·94	2·0	86·0	11·4	1·1	1290
9	1·067	16·2	9·2	13·92	2·2	85·9	12·0	0·7	1280
10	1·062	15·2	8·6	12·72	2·4	83·6	11·4	0·7	1240
11	1·067	16·4	9·3	13·93	2·4	84·9	11·1	1·1	945
12	1·065	15·9	9·0	13·42	2·4	84·4	11·6	1·0	1095
13	1·062	15·2	8·6	12·8	2·4	84·2	11·1	0 8	1300
14	1·062	15·2	8·6	13·18	2·0	86·6	11·5	0·7	1273
15	1·064	15·7	8·9	13·09	2·6	83·2	11·4	1·2	1100
16	1·064	15·7	8·9	12·99	2·7	82·7	11·0	1·1	1082
17	1·063	15·5	8·8	13·45	2·0	86·7	11·3	1·1	873
18	1·060	14·8	8·4	12·67	2·1	88·6	11·2	0·9	970
19	1·062	15·2	8·6	12·64	2·5	83·1	11·3	0·8	1223
20	1·059	14·4	8·2	12·15	2·2	84·3	10·6	1·2	1168
21	1·063	15·3	8·6	12·69	2·6	82·9	11·6	0·9	1200
22	1·064	15·7	8·9	13·15	2·5	83·7	11·9	0·9	1260
23	1·063	15·3	8·6	12·99	2·3	84·9	11·4	1·1	1080
24	1·063	15·3	8·6	12·91	2·3	84·3	11·3	0·7	12·85
25	1·062	15·1	8·5	12·72	2·3	84·2	11·1	0·8	975
26	1·060	14·7	8·3	12·42	2·2	84·4	10·6	1·1	1150

The course of the 1897 experiments was as follows: owing to unfavourable weather conditions the canes did not develop full maturity. Violent storms in September, followed by almost equally strong ones in November, laid low more or less of the eight months' old cane, and in the first few days of December a sharp hoar frost put in an appearance. This frost (being of a kind which, while unexpected, lasts but a night or two, and is accompanied by a north wind) attacks all cane fields not protected by adjacent hills, affecting the canes in the tenderest top portions where the youngest leaves branch out from the stem. On subsequently examining the field and dividing lengthways a sample cane top, a more or less distinct brown colouring is found in the tenderest top portion as a result of the frost. Under these circumstances the green leaves soon wither; the process of ripening and sugar formation stops, the sugar content, on the contrary, deteriorates, decomposes, and ferments on the field, as the fluctuations of temperature between day and night frequently amount

to as much as from 25° to 30°C. Whereas for example, the average figures for sugar content during the campaign of the preceding year 1896-97 came to 14·0%, in 1897-98 it only reached 11%. The 1897 experiment fields naturally did not escape unscathed, and were equally affected by the strong storms and the frost.

The germination and raising of the cuttings progressed in a regular manner. After a short while it could be seen that the unmanured plots were slower in developing, with the exception of the top cuttings which equalled the manured cane in colour and growth. The best results were attained by plot No. 5, manured with nitrogen and potash.

If we first consider experiments 0, 1, 9, 26 (without manure), then the difference in the figures of yield is very striking. The lowest portion of planted cane stem No. 26 yielded the poorest results for a given area, the top portion the best. The top part yielded an excess of 3,500 kg. cane over that of the middle part, and 17,500 kg. cane over the lowest part per hectare when no manure was applied. This confirms fully the supposition arising out of the experiments. It is not correct to plant out the richest portions of the lower stem (as was erroneously recommended to the planters by the French sugar factories), but on the contrary one should select the most germinative part of the stem that is richest in sugar. The young upper part of the stem, owing to the collecting of the juice in it, has physiologically a greater vitality than the middle or lower parts. The stem nodes are still fresh and develop germination more quickly and powerfully to begin with, and this has its influence on the whole subsequent period of growth. The experiments show distinctly that the upper portions of the cane must be employed for planting out.

The different selected artificial manures could not, owing to the injury caused by the above-mentioned storms and frosts, obtain full scope for their action, and it is therefore impossible to draw definite results from the 1897 experiments. If we calculate the amounts of sugar obtained for a given area arising out of these experiments, then we have the following summary :—

Amounts of sugar obtained per hectare and acre in connection with the 1897 Field Experiments with First Year Cane (a frost year).

No.		Kilo. of Sugar per hectar.	* Lbs. of Sugar per acre.
0	Without manure. With whole canes as cuttings ..	6513 ..	5808
1	,, ,, ,, treble-noded ,, ..	8756 .	7909
2	With saltpetre	8252 ..	7358
3	,, ,, ...	8248 ..	7355
4	,, ,, and superphosphate	7376 ..	6577

* 1lb. = 0·454 kilos. 1 kilo. = 2·2026lbs. 1 hectar = 2·47 acre.

No.		Kilo. of Sugar per hectar.	Lbs of Sugar per acre.
5	With saltpetre and sulphate of potash	8335	7432
6	,, ,, ,, ,, ,, and superphos.	8827	7871
7	Saltpetre, sulphate of potash, superphos. and lime.	7618	6793
8	,, ,, ,, ,, ,,	8126	7246
9	Without manure. Cuttings from middle of stem	7493	6681
10	With superphosphate	7687	6854
11	,, ,,	6270	5591
12	,, ,, and sulphate of potash	6870	6126
13	,, ,, ,, ,, & saltpetre	7957	7095
14	,, ,, ,, ,, ,,	7830	6982
15	,, ,, and lime	7563	6744
16	Sulphate of ammonia and superphosphate	8132	7251
17	,, ,, ,,	7665	6835
18	,, ,, ,, and lime.	8657	7711
19	,, ,, and lime	7568	6749
20	Potash magnesia and saltpetre and superphosphate	7252	6467
21	,, ,, ,, ,,	7370	6572
22	,, ,, ,, ,,	7283	6494
23	,, ,, ,, ,,	7377	6579
24	Lime	7933	7074
25	Lime	7332	6538
26	Unmanured; lowest cuttings	6017	5365

From the foregoing tables we may draw the following conclusions:—

No. 0 served as a test plot and without manure yielded a crop of 61 metric tons of cane per hectare = 24·7 tons of cane per acre; or 6·5 metric tons sugar per hectare = 2·6 tons of sugar per acre.

Adjacent to these stood fully manured plots, Nos. 6, 7, 8, 13 and 14, with an average yield of 76 metric tons cane, the maximum being 84·6 tons per hectare = 30·7 to 34·2 tons cane per acre; or 8 metric tons sugar, the maximum being 8·8 tons per hectare = 3·2 to 3·5 tons sugar per acre.

The potash and nitrogen plots (2 to 8) with an average yield of 76·4 metric tons cane per hectare = 30·9 tons of cane per acre; or 8·1 metric tons sugar = 3·2 tons sugar per acre were superior to the ammonia-nitrogen plots (Nos. 16 to 19) which averaged 70·6 metric tons cane per hectare = 28·5 tons of cane per acre; or 8·0 metric tons sugar = 3·2 tons sugar per acre.

The superphosphate plots (10 to 15) averaged 69·5 metric tons cane per hectare = 28·1 tons of cane per acre; 7·3 metric tons sugar per hectare = 2·9 tons sugar per acre.

With superphosphate alone the manured is not better than the unmanured. With the addition, however, of nitrogen, there is an increase in the yield (Nos. 13, 14).

The results were not particularly controllable in the case of the manuring with potash of canes remaining unripe, perhaps in the fully manured plots with N and P_2O_5 in spite of the fact that potash is one of the most important plant nutriments, especially for the sugar cane, and was observed to be working well on the potash plots (Nos. 5 to 8 and 12 to 15) during their growth.

Large doles of magnesium potash had no result, no more than large applications of lime. All the observations and experiments made led to the conclusion that nitrogenous manuring in the given proportions had the greatest apparent influence on the cane in Upper Egypt. In determining between saltpetre and ammonium nitrate one had better give preference to the former as well on financial as on technical grounds. From different experiments the writer found it most important for canes, and other cultures too, that the saltpetre should in every case be given just after a watering. One should sprinkle the saltpetre in measured quantities (mixed with sandy soil) along the plant rows as soon as the irrigation water has had one or two days to settle. Then the saltpetre is enabled to act to its fullest capacity and when on the expiration of a fortnight, a fresh watering takes place, it will not be further dissolved or washed away, because it will then have been absorbed by the plants.

In the foregoing the writer has given all the particulars that were to be derived from the 1897 experiments. The analyses and the crop figures in this exceptional year gave no definite grounds for forming a judgment, and therefore must be accepted with every reserve. Possibly they may prove serviceable for purposes of comparison with later years, yet in spite of the failure of the trials, observations made during the vegetation enabled one to see that the sugar cane and the soil of the Nile Valley are particularly capable of absorbing mineral manures, and that this produces a large increase in the crop as compared with unmanured cane.

II. Field Manuring Experiments with Sugar Cane, 1898.

(a) *First Year Canes.*

In the year 1898 field experiments were undertaken on first and second year canes. Owing to the planting falling in the time of the campaign work, and the station being fully occupied in controlling the cane deliveries so as to sort out the frost-bitten and rotten canes, only a few experiments in fresh planting were possible.

The area of the experiment field of 1898 first year cane amounted to 3,515 square metres and was divided into three oblong plots. The method and planting employed was different this time. The use of top cuttings was out of question, because nearly all the cane was more or less touched by frost and the bud eyes on the top stems thereby killed. A selection of plant material was made in this wise: From the best conditioned fields such as were planted the

previous year with top cuttings the strongest, best developed canes were chosen for cuttings.

In Plot No. 1 the selected canes were planted in rows 1 metre apart.

In Plot No. 2 the cane, also selected, was planted in rows 1·20 metres apart.

In Plot No. 3 the cane (unselected) was planted according to the customary Arab method.

The manures employed were distributed as follows :—

Plot No. 1. (1,000 sq. metres).	Plot No. 2. (1,000 sq. metres).	Plot No. 3. (1,515 sq. metres).
30 kg. Saltpetre 50 kg. Thomas slag 75 kg. Molasses ash	30 kg. Saltpetre 50 kg. Thomas phosphate 75 kg. Molasses ash	*No Manures.*

Nos. 1 and 2 were thus equally manured, while No. 3 remained unmanured. By means of this demonstrative experiment the results of full manuring and selection, as compared with unmanured Arabic methods, were looked forward to, and were distinctly shown in the subsequent crop yields. These field tests under equal treatment took a normal course during the whole period of vegetation. The arrangement of wider planting intervals, 1 metre with "single" and 1·20 with "double" rows of cuttings, was distinctly superior to the Arabic arrangement with intervals of only 0·70 metre. The sugar contents of these three parcels was most satisfactory, and showed that the canes grown from carefully-selected cuttings, and treated with manures (Nos. 1 and 2), gave better results than No. 3. The quantitative yields were as follows :—

Crop Yields of 1898 Experiments (*First Year Canes*).

No.	Kg. Canes. per hectare.	Cantars Cane per feddan.	Lbs. per Acre.
1	79,546	742	70,935
2	83,132	775	74,133
3	56,937	531	50,774

Analyses of Results from 1898 Experiments
(*First Year Canes*).

	1	2	3
Sp. Gr.	1·072	1·072	1·068
Brix	17·4	17·4	16·5
Baumé	9·8	9·8	9·3
Sugar in Juice	14·41	14·67	13·47
Non-sugar	2·9	2·7	3·0
Quotient	82·8	84·3	81·1
Sugar in Cane	12·4	12·5	11·7
Glucose	0·6	0·6	0·8
Average weight per cane stem	1,418 gr.	1,408 gr.	1,346 gr.

(b) Second Year Canes.

For the proposed experiments with second year canes, the observations and results of the 1897 field experiments were taken into consideration; in particular, the established influence of nitrogenous manuring. Moreover, the general appearance, the pale-lead colour of the leaves of the second year plants in nearly all fields betokened a want of nitrogen. Consequently, the 27 plots of 1897 first year canes were used with the same division for the 1898 second year experiments, and besides that, the two chief nitrogenous manures, saltpetre and sulphate of ammonia, were employed in contradistinction to the otherwise needed customary native manuring mediums. All 27 plots obviously received the same handling save as to manures. The loosening of the soil between plant rows and the heaps was done by ploughs. This work, undertaken with care—that is, guiding the animal straight—being found ever so much better and more advantageous than hand work with the hoe. The individual plots were manured as follows:—

FIELD MANURIAL EXPERIMENTS, 1898 (Second year canes).

27 plots of 625 sq. metres.

No.	
0., 1., 2.	Unmanured.
3 to 8.	Dove guano, 3 ardebs.
9.	Unmanured.
10., 11.	Saltpetre: 200 kgr. per hectare = 180 lbs. per acre.
12., 13.	Saltpetre: 400 kgr. per hectare = 360 lbs. per acre.
14 to 17.	Old ruins manure (zebach adim) 16 cubic metres per hectare.
18 to 21.	Sulphate of ammonia $(NH_4)_2SO_4$, 400 kg. per hectare = 360 lbs. per acre.
22 to 26.	Unmanured.

An analysis of the manuring mediums employed gave the following proportions of plant nutriment:—

	Nitrogen. Per cent.	P_2O_5 Per cent.	K_2O Per cent.
Egyptian dove guano	4·2	1·9	2·8
Ruins manure	0·5	0·2	2·9
Saltpetre	15·5	—	—
Sulphate of ammonia	16·6	—	—

Dividing the plots according to the manures applied we obtain the following results:—

Ox Shovel for Levelling the Field.

Wooden Block used in place of Rollers to crush hard lumps, called "Kassára."

	Kilograms per hectare.		Cane. Cantars per fadden.		Lbs. per acre.
1. Unmanured—					
Nos. 0, 1, 2, 9, 22, 23, 24, 25, 26 ..	26,925	..	251·2	..	24,009
2. With Dove Guano—					
Nos. 3, 4, 5, 6, 7, 8	31,900	..	295·0	..	28,444
3. With Saltpetre—					
Nos. 10 and 11	44,708	..	416·6	..	39,861
4. With Saltpetre (double)—					
Nos. 12 and 13	55,156	..	514·7	..	49,185
5. With Sulphate of Ammonia $(NH_4)_2SO_4$—					
Nos. 18, 19, 20, 21	44,528	..	415·5	.	39,700
6. Ruins Manures—					
Nos. 14, 15, 16, 17	29,150	..	272·0	..	25,991

Analysis of Field Experiments, 1898 (Second Year Cane).

Nos.	Averages.								Average weight per Cane Stem.
	Specific Gravity	Brix.	Baumé.	Sugar in Juice.	Non-Sugar.	Quotient.	Sugar in Cane.	Glucose	
0, 1, 2, 9, 22-26, Unmanured	1·081	19·4	10·9	16·69	2·7	85·9	14·1	0·4	526
3, 4, 5, 6, 7, 8, Dove guano.	1·079	19·0	10·7	16·12	2·9	84·5	14·0	0·3	602
10, 11, Saltpetre.	1·081	19·5	11·0	16·48	3·0	84·3	14·2	0·5	870
12, 13, Saltpetre (doubled).	1·079	19·0	10·7	16·21	2·7	85·3	13·9	0·5	858
18, 19, 20, 21, Sulphate of potash.	1·079	19·0	10·7	15·96	3·0	84·0	13·6	0·6	800
14, 15, 16, 17, Ruins manure.	1·078	18·7	10·5	15·95	2·8	84·9	13·7	0·6	519

A glance over the figures of yields of the above experiments shows distinctly enough the tolerably large difference between particular experiment rows. Considering the analysis of the natural manuring mediums hitherto employed in the country reveals so small a content in those plant nutriments which the sugar cane stands so absolutely in need of, it is only to be expected that a good result would be hard to obtain. The plots treated with dove guano (Nos. 3 to 8) show

against the unmanured, under about equal sugar contents, an increase of about 18 per cent. of cane, but even then involve a financial deficit for the planter, since the dove guano, which is found especially in the Upper Egyptian villages, is too high in price, and its general adoption by the majority is out of question, as it does not exist in large quantities. It is chiefly used by the fellah for maize culture, as the latter being his main food supply he looks well after it.

The *ruins* manure—called *zebach adim*—must be considered of comparatively little value, to judge by its analysis and the yields obtainable from its application. It is brought as rubbish from abandoned settlements centuries old, but this is in most cases a waste of labour.

For the physical improvement of the heavy soil it may perhaps have an advantage, which, however, is not commensurate with the cost of procuring and transporting it. Sand from the Nile islets could be just as well employed, and in other countries the experimental soils are actually treated with it.

The saltpetre plot is divided into "single" and "double" applications of manure. The "single" measured quantity of 200 kg. per hectare, or 180 lbs. per acre, produced an increase of 17,700 kg. cane, and the "double," one of 28,230 kg. per hectare, or 15,784 and 25,174 lbs. per acre, over the unmanured. The parcels treated with sulphate of ammonia had a similar good yield of 17,600 kg. per hectare, or 15,694 lbs. per acre over the unmanured, but were inferior financially to the saltpetre plots. Preference should certainly be given to saltpetre over nitrate of ammonia, particularly under the conditions of Egyptian soil and irrigation. The correct method of employing saltpetre was already mentioned in connection with the first year experiments. The application of saltpetre produced roughly 100 per cent. increase, as can be seen in the foregoing tables of yields. The crop figures of the nitrogen plots show doubled production for the given area. The pronounced want of nitrogen on the part of the second year canes was likewise made clear by these parallel experiments, and similarly the superiority of saltpetre to all other manuring mediums for supplying this want was plainly demonstrated.

(To be continued.)

Exports from British Guiana, from January 1st to 5th March, 1903: sugar, 33,962 tons; rum, 1,013,804 gallons; molasses, 2,098 casks; molascuit, 115 tons; cocoa, 21,030 lbs.; against 33,796 tons; 1,239,467 gallons; 645 casks; 0 tons; and 26,656 lbs. respectively for the like period last year.

METHODS FOR THE DETERMINATION OF TOTAL PHOSPHORIC ACID AND POTASH IN SOILS.

BY C. B. WILLIAMS.

(Journ. American Chemical Society.)

Agricultural chemists have seemingly, in recent years, placed too little stress upon the determination of total plant food in soils, as a knowledge of the quantity present is necessary for a thorough understanding of the potentialities, culture methods, and fertilizer requirements of any soil, as well as entering vitally into the interpretations given availability results. With these facts in mind, the writer has, during the past summer, devoted some time to modifying well-known analytical methods to a reasonable rapid basis for the determination of total phosphoric acid and potash in soils.

STUDY OF DIFFERENT SOLVENTS FOR PHOSPHORIC ACID.

The results of work with the action of different solvents on phosphoric acid are incorporated in Table I, and it will be seen that the results obtained by the last six modes of treatment are practically identical, and uniformly low, while those by the hydro-fluoric acid-fusion method,* are perceptibly higher. Fusion of the residues from treatment by the last six methods invariably gave a slight test for phosphoric acid, while, of course, this was not true of the first method, as the residues were entirely decomposed by fusion with sodium and potassium carbonates.† The soils were ignited before treatment by the first four methods, but not with the last three.

TABLE I.—COMPARISON OF METHODS FOR EFFECTING SOLUTION OF SOIL PHOSPHORIC ACID WHEN 10 GRAMS SOIL ARE EMPLOYED.

		Heated on water-bath for $1\frac{1}{2}$ hours.		Digested in Kjeldahl flask $1\frac{1}{2}$ hours.			
Soil. No.	Treated three times with HF and then fused with 10 grams Na_2CO_3—K_2CO_3. Per cent. P_2O_5.	With 30 cc. HCl. Per cent. P_2O_5.	With 30 cc. HNO_3. Per cent. P_2O_5.	With 50 cc. HCl + 20 cc. HNO_3. Per cent. P_2O_5.	With 50 cc. HCl. Per cent. P_2O_5.	With 50 cc. HCl followed by digestion 1 hr. with 10 cc. HNO_3. Per cent. P_2O_5.	With 40 cc. HCl + 1 gram $KClO_3$. Per cent. P_2O_5.
1	0·0330	0·017	0·016	....	0·017	0·017	....
		0·017	0·015	....	....	....	....
2	0·0292	0·017	0·014	0·017	0·016	0·015	0·016
		0·015	0·014	0·017	....	....	0·017
3	0·0212	0·016	0·014	0·013	0·015	0·015	0·014
		0·015	0·014	....	....	....	0·012

As the hydrofluoric acid-fusion gave results uniformly higher, and representing, we think, all the phosphoric acid in the soil, it has been

* *Vide* Fresenius, "Quantitative Analysis," pp. 424-426.
† *Ibid.*, pp. 422-424.

adopted for the determination of total phosphoric acid in soil survey work in North Carolina. It might be objected that higher results by this method are due to the possible presence of ammonium silicomolybdate, as in the dehydration of silica from the fusion with sodium and potassium carbonates there was only one evaporation to dryness; but this would seem unfounded, as silica gives no reaction in the cold,* and only a strong yellow coloration upon heating.

Determination of Phosphoric Acid Volumetrically versus Gravimetrically.

The volumetric method used is described in this Journal, 23, 8-12,† while the gravimetric one employed is the regular official method of the Association of Official Agricultural Chemists. For a test of the relative merits of these two methods of estimating phosphoric acid in soils, where the quantity usually is less than 0·1 per cent., twelve soils (Nos. 23-24) were employed, using solutions obtained by digestion in the water-bath for ten hours, with 1·115 sp. gr. hydrochloric acid, shaking thoroughly each hour. The quantity was determined separately in each twelve original and duplicate soils, the total amount from the twelve originals being 0·0260, and from duplicates 0·0280 gram. When the totals of the originals and duplicates were dissolved separately with hydrochloric acid, and redetermined by precipitation with magnesia mixture 0·0199 gram phosphoric acid for originals and 0·0198 for duplicates were obtained.

Results on the same twelve soils by the volumetric method, making determinations separately and adding, gave originals 0·0210 gram phosphoric acid and duplicates 0·0193 gram, which are very close to the composite original and duplicate gravimetric results.

In the light of these results, the volumetric method is considered by far the most accurate for soil work where the percentages of phosphoric acid are usually very low.

Solution of Potash in Soils.

Results in Table II on soils No. 1, 2, and 3 indicate that after ignition and evaporation with hydrofluoric acid five times it is unnecessary to fuse with sodium carbonate, as all potash-bearing silicates have been decomposed, leaving the potash in a form that it is easily dissolved by the treatment subsequently given it in the method described elsewhere in this paper.

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* Fresenius' "Qualitative Analysis," p. 332. F. P. Veitch states, however, that silicic acid gives a yellow coloration in the cold (private communication).

† *Vide* this Journal, 15, 382; *J. Frank, Inst.*, 136, 362; U. S. Dept. of Agriculture, Div. of Chem., Bull. 43, pp. 68-97; *Ibid.*, Bull. 47, pp. 62-82; *Ibid.*, 49, pp. 60-77; *Ibid.*, 51, pp. 47-56; *Ibid.*, Bull. 56, pp. 36-48; *Ibid.*, Bull. 62, pp. 35-41; *Ibid.*, Bull. 56, pp. 36-48: *Ibid.*, Bull. 67, pp. 22-26.

TABLE II.

Soil. No.	Treated five times with HF. Per cent. K_2O.	Treated five times with HF, followed by fusion with Na_2CO_3. Per cent. K_2O.
1	0·204	0·216
2	0·242	0·242
	0·232	0·232
3	0·187	0·190
	0·180	0·191

It might be said here that the reason for using the first evaporation with sulphuric acid in the potash method is that a preliminary test upon soils Nos. 6, 11, 13, 15, and 16 worked in duplicate indicated that there was a slight loss in potash if the soils were not saturated with this acid before ignition; the loss probably occurs principally from the volatilization of potash in organic combination.

MOORE'S METHOD.*

With reference to the method of Moore for the determination of total potash in soils I found that as long as the combined amount of iron and alumina remained as low as 2 or 3 per cent., it works very well, although in my hands giving slightly low results, but when from 8 to 12 per cent. of iron and alumina are present, trouble comes from caking upon evaporation to a pasty constituency with platinic chloride, the cake not being dissolved by Moore's acid alcohol, even after standing two or three days.

METHOD FOR THE DETERMINATION OF TOTAL PHOSPHORIC ACID IN SOILS.

Five grams of soil prepared by passing through a sieve with apertures 0·5 mm. in diameter are placed in a platinum dish and ignited until organic matter has been destroyed; then treated three times with hydrofluoric acid, evaporating to dryness each time on a water-bath, using a platinum rod to stir upon each addition of acid. The residue thus obtained is mixed with 10 grams of a mixture of equal parts of sodium and potassium carbonates, and reduced in an agate mortar to a fine powder, after which it is heated over a blast-lamp, gently at first, until the mass has completely agglutinated, when stronger heat is turned on and continued until calm fusion is attained. Then cool and place the dish and its contents in a beaker, and add sufficient (1 : 1) hydrochloric acid to cover the dish. Place on a water-bath and digest until the mass has thoroughly loosened from the dish, after which it is removed. Evaporate to dryness on a water-bath and thoroughly dehydrate the silica present by finishing the heating in an air-bath at 110° C. for four or five

* U. S. Department of Agriculture, Bureau of Chemistry, Circular 9, pp. 5-7.

hours. Take up with dilute hydrochloric acid and digest on water-bath for twenty to thirty minutes, after which filter from silica, washing the same thoroughly to remove last traces of phosphoric acid. To the filtrate is added sufficient nitric acid to liberate all hydrochloric acid, and the solution is evaporated to a volume of about 40 cc. Then neutralise the excess of nitric acid with ammonia, and add 10 to 12 grams of ammonium nitrate. After cooling, 30 cc. of recently filtered molybdic solution are added and the phosphoric acid precipitated by shaking in a Wagner machine, and determined volumetrically.*

Method for the Determination of Total Potash in Soils.

After saturating 4 grams of soil in a platinum dish thoroughly with dilute (1 : 1) sulphuric acid, dispel the excess of acid by gentle heat over a low flame, exercising care that no loss occurs from spurting. Next treat with 2 to 3 cc. hydrofluoric acid (free from potash) five times, using a platinum rod to stir occasionally, and evaporate each time to apparent dryness on a water-bath, but just before going to dryness the last time 1 cc. dilute sulphuric acid is added and the heating continued until practically all hydrofluoric acid and water have been driven off. The dish is then heated over a small flame until the evolution of sulphur trioxide ceases. When this is finished, about 20 cc. distilled water, slightly acidified with hydrochloric acid, is added, and digested on a water-bath, stirring occasionally until the liquid has been reduced to about one-third of its orginal volume. By this time complete solution of the potash has been effected, and the whole contents of the dish are transferred with water to a 200 cc. graduated flask, which is afterwards heated on a water-bath to near boiling, when ammonia and ammonium oxalate are added in sufficient quantities to precipitate all iron, alumina, and calcium present (2 cc. have been found sufficient). Allow the solution to cool, shaking two or three times during cooling to reduce the error of occlusion as much as possible. The volume is then made to 200 cc., and an aliquot portion corresponding to 2 grams of soil is filtered off into a porcelain dish and evaporated to semi-dryness on a water-bath, finishing by heating cautiously over a gentle flame, being careful that loss occurs neither from creeping nor decrepitation. When dry, ignite gently to decompose oxalates and expel ammonium salts. Take up with 10 to 15 cc. of hot distilled water, acidify with three or four drops of hydrochloric acid, and filter. Determine the potash in the filtrate by precipitation with chloroplatinic acid, &c., as directed in the regular Lindo-Gladding method.

* This Journal, 23, 8-12.

FUNGICIDES AND INSECTICIDES.

The following, which was originally published in the Journal of the Royal Horticultural Society of England, will, we believe, be found of interest to our readers.

FUNGICIDES.

Bordeaux Mixture.

4 lb. copper sulphate (blue vitriol).
4 lb. lime (unslaked).
25—50 gallons water.

Dissolve the copper in hot or cold water, using a wooden or earthen vessel. Slake the lime in a tub, adding the water cautiously and only in sufficient amount to insure thorough slaking. After thoroughly slaking, more water can be added and stirred in until it has the consistency of thick cream. When both are cold pour the lime into the diluted copper solution of required strength, straining it through a fine mesh sieve or a gunny cloth, and thoroughly mix.

The standard mixtures are:—

(*a.*) 25 gallons (full strength solution, or 4-4-25 formula).
(*b.*) 50 gallons (half strength mixture, or 4-4-50 formula).

It is then ready for use. Considerable trouble has frequently been experienced in preparing the Bordeaux mixture. Care should be taken that the lime is of good quality and well burned, and has not been airslaked. Where small amounts of lime are slaked it is advisable to use hot water. The lime should not be allowed to become dry in slaking neither should it become entirely submerged in water. Lime slakes best when supplied with just enough water to develop a large amount of heat, which renders the process active. If the amount of lime is insufficient, there is a danger of burning tender foliage. In order to obviate that, the mixture can be tested with a knife-blade or with ferrocyanide of potassium (1 oz. to 5 or 6 ozs. of water). If the amount of lime is insufficient, copper will be deposited on the knife-blade, while the deep brownish-red colour will be imparted to the mixture when ferrocyanide of potassium is added. Lime should be added until neither reaction occurs. A slight excess of lime, however, is desirable.

The Bordeaux mixture is best when first prepared. Stock solutions of lime and copper can be made and mixed when required.

The following, known as the 6-4-50 formula, is in very general use:—

6 lb. copper sulphate.
4 lb. lime.
50 gallons water.

Copper Sulphate Solution.

(Strong Solution.)

1 lb. copper sulphate.
25 gallons water.

Copper Sulphate Solution.

(Weak Solution.)

2-4 oz. copper sulphate.

50 gallons water.

For trees in foliage.

Potassium Sulphide.

3 oz. potassium sulphide.

10 gallons water.

Valuable for Gooseberry mildews, &c.

Potassium Permanganate.

1 part potassium permanganate.

2 parts soap.

100 parts water.

Recommended in France for black rot and mildew of the Grape, &c.

Iron Sulphate and Sulphuric Acid.

Water (hot), 100 parts.

Iron sulphate, as much as will dissolve.

Sulphuric acid, 1 part.

Prepare solution before using. Add the acid to the crystals and then pour on the water. Valuable for treatment of dormant Grape vines affected with anthracnose, application being made with a sponge or brush.

INSECTICIDES.

Resin Lime Mixture.

5 lb. pulverised resin.

1 lb. concentrated lye.

1 pint fish or other animal oil.

5 gallons water.

Place the oil, resin, and one gallon of hot water in an iron kettle and heat till the resin softens, then add the lye and stir thoroughly; now add four gallons of hot water and boil till a little will mix with cold water and give a clear amber-coloured liquid; add water to make up five gallons.

Keep this as a stock solution. For use take:—

1 gallon stock solution.

16 gallons water.

3 gallons milk of lime.

¼ lb. Paris green.

The object of this preparation is to obtain an adhesive material which will cause the poison to adhere to smooth leaves. It has been highly recommended by the New York State (Geneva) Experimental Station.

Lime, Salt and Sulphur.

50 lb. unslaked lime.

50 lb. flowers of sulphur.

50 lb. common salt.

Slake the lime in enough water to do it thoroughly; add the sulphur and boil for an hour at least, adding water if necessary. Then add the salt and boil 15 minutes more. Add water to make 150 gallons and spray hot through a coarse nozzle.

LIME, SALT AND SULPHUR.

(Marlatt's Formula.)

30 lb. unslaked lime.
30 lb. sulphur.
15 lb. salt.
60 gallons water.

Boil with steam for four hours and apply hot.

INSECT POWDER.

(Pyrethrum.)

Mix with half its bulk of flour and keep it in a tight can for 24 hours; then dust over the plants, or:—

100 grains insect powder.
2 gallons water.

Mix together and spray.

IVORY SOAP.

1 bar ivory soap (sixpence size).
15 gallons water.

Apply warm, as it thickens on cooling. Recommended for rose mildew, red spider, plant lice, &c.

THE STANDARD BOILING GAUGE FOR ACCURATE BOILING AND FINISHING OF MASSE-CUITES, SYRUPS, MOLASSES, &c.

By GEORGE STADE, Berlin.

Sugar boiling is one of those few manipulations in the sugar industry, where theory means nothing and the practical art is everything. Up-to-date science can give the pan-boiler but very little help, no chemical formulæ are of any use here. The best manual of instruction and the most specified analysis are utterly unable to teach how a strike of sugar or molasses-syrup has to be boiled in the best possible way. This art of boiling sugar can only be acquired in practical working and by long personal experience. For a long time to come this will remain so, and good sugar and particularly refined qualities, as candy, loaves, certain kind of cubes, Demerara crystals, and special marks of granulated will always be more or less dependent on the skill of the sugar boiler.

However, a considerable help to the pan-boiler and an important guide to the manager is given now by using the "Standard Gauge" to ascertain that point of density

masses when it is necessary either to draw in liquor (with granulated masse-cuite) or to stop boiling (with low-products boiled to density or with candy masse-cuites in refineries).

It is well known that even the very best pan-boiler is unable to boil, for instance, always the same quality second sugar. It often happens that with exactly the same masses, one second sugar strike gives 25 per cent. and the next one 35 per cent. yield. Many inconveniences and losses are often the result of this uneven work.* These drawbacks can be done away with entirely if the Standard Gauge is used:—

1. For molasses boiled to sling, or gelée, or "blanc" as low-products, or molasses syrup, or candy liquor in the refinery.

2. The exact point of concentration can be determined and the concentration of one strike can be made exactly like another.

3. For processes in use now in modern factories and refineries for granulating syrup molasses or low-products in the pan such as the Standard Process a rigorous control is necessary to ascertain always the right point of concentration or supersaturation of the boiling masses.

4. For raw sugar works making first sugar only and exhausted waste molasses in one operation in 35 to 40 hours. Here also the knowledge of the degree of concentration is of vital importance for the whole boiling operation.

5. For all sugar works and refineries working in the usual style first products for consumption or re-melting purposes obtaining either highest yields possible and mother liquor of highest possible exhaustion, or as in refineries—more equal products as hitherto possible with the usual controlling implements.

To sum up: The acceptance of the Standard Gauge altogether is a move in the right direction not in order to do away with personal skill but to prove an aid to pan-boiler and superintendent and make the success of the boiling operation not entirely dependent on eye, proof-stick and sample-glass.

The instrument consists of three scales.

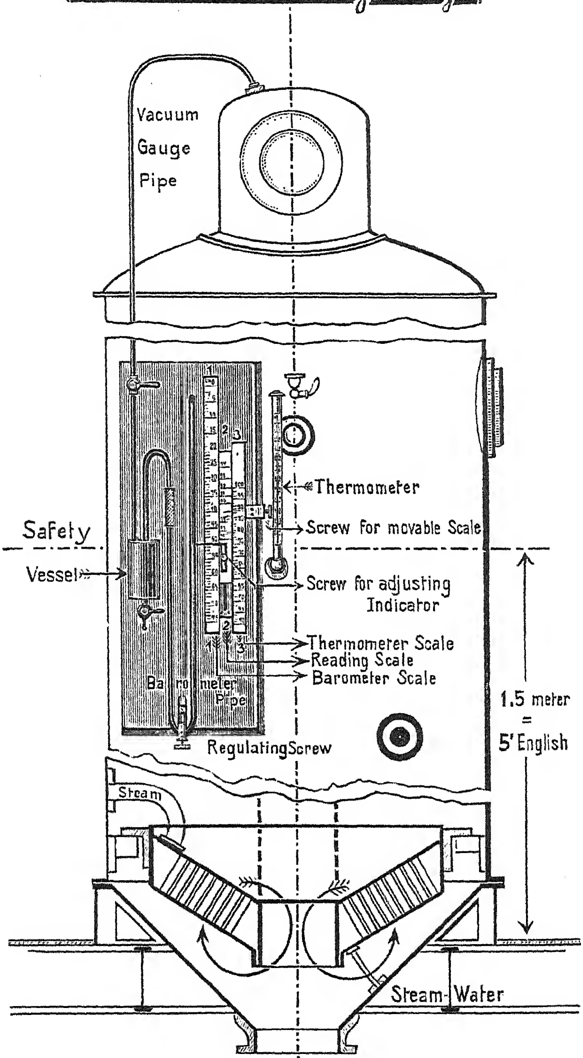
1. The barometer scale showing exact vacuum in the pan in centimeters or millimetres.

2. The density scale drawn up by scientific rules from combination of temperature and vacuum.

3. The thermometer scale giving temperature of boiling masses in Centigrades-Celsius (the thermometer itself is fixed separately to the Standard Gauge as will be seen below).

* To show this by an example: Say a factory is making 500 tons molasses sugar out of 1,500 tons masse-cuite, and by proper and even boiling with the Standard Boiling Gauge a better yield of *only 1 per cent.* could be secured. This means consequently: 15 tons of sugar saved or equal to say £120 or $600 nett clearance.

Patent Circulating Express Vacuum Pan (with Standard Boiling Gauge.)



Fitting up: The middle of the instrument has to be placed at the height of one's eye (say 1·5 metres = 5 ft.) from the floor on which the pan-boiler stands, near the eye-glasses, proof-stick, and draw-in valves, so that the scales of barometer and thermometer can be readily scanned.

The Thermometer: Has to be fitted up in such a way that it always touches the boiling masses. Particular care has to be taken, however, that the thermometer does not touch either steam-coil or jacket as its indications in this way become erroneous. The thermometer has to enter the pan at least 4 inches or 100 millimetres. In case it comes in contact with a steam-coil it has to be drawn out far enough to avoid a close contact.

The Barometer board: Is fixed best on the left side of the thermometer, so that scale 3 is nearest to it. The board has to be fixed in such a way that it does not come in direct contact with the pan nor with the lagging. A few inches play are necessary to prevent it getting warped. The best way is to take two small U irons of $\frac{1}{5}$ in. (5 millimetres) to fix across behind the board and screw down these irons on the lagging. Do not fix the board directly on the pan nor on the lagging. The board being fixed as pointed out, the vacuum pipe is now connected with the dome of the vacuum pan with an ordinary gauge pipe of copper. Care has to be taken that no boiling masses can choke this pipe. The barometer-pipes are connected then by an india-rubber hose, so that their ends come into close contact.

The barometer-pipe is closed up with a stopper to prevent the mercury escaping. Before taking out the stopper in order to connect vacuum pipe and barometer pipe it has to be seen that no air-bubbles have entered the closed long end of the barometer pipe. However, in fixing the barometer the closed end has to contain a small vacuum and in order to facilitate this, a little mercury can be removed from the open end. The barometer pipe is fixed now in such a way that it can be moved a little by hand so that the screw is not entirely tight as otherwise a warping might break the glass.

To fix the instrument after everything has been put in order and the connecting cock opened, the vacuum of the boiling-pan has to be first measured in millimetres, that means the difference of the two heads of mercury has to be ascertained in millimetres, say the difference is 14 millimetres, then the vacuum of the pan is 760, less 140 equal to 620 millimetres or 62 centimetres. Now scale (1) has to be adjusted so that the head of mercury stands exactly at 62 of that scale. If this is not the case the barometer pipe has to be moved up or down by means of the screw below so that an exact reading is obtained. The exact reading means always the top of the convex surface of the mercury. As a rule the Standard Boiling Gauge is gauged at a vacuum of 62 centimetres say $24\frac{7}{16}$ in. The vacuum gauge has to be checked every now and then with a meter as this is the fundamental

point of the instrument. Once the exact vacuum can be read at scale 1, the density of the boiling masses can be obtained at once.

1. Put top of indicator (1) level with convex surface of mercury by moving " screw for moveable scale 2 " up or down.

2. Now read the temperature of the boiling masses as indicated by the thermometer to the right.

3. Look at scale 3 at the figure indicated and read off the figure opposite of the indicator in the same height on scale 2. This figure on scale 2 gives the density of the boiling masses.

To start the practice of boiling and boiling down with the Standard Boiling Gauge the following rules may be given:—

1. Never read off while drawing in liquor, wait until the liquor is equally mixed up in the whole pan.

2. To get a practical result compare always two or three readings.

3. For boiling generally keep a book putting down the readings, first, at the finishing of drawing in, and secondly, before drawing in again. Of course, in boiling with the liquor entry valve open only check of time is required to be always admirably informed about the state of the boiling operation by the density indicated on the Standard Boiling Gauge.

4. In boiling down and finishing a strike get your best pan-boiler to boil down in the way you found out that your yield or your sugar gives best satisfaction. Fix thus the last point of the boiling operation by the Standard Boiling Gauge readings. Once you get the right concentration and you know the readings of your instrument you are always able to fix exactly the concentration required. You can employ any unskilled man to boil your low-products, while for granulated qualities the instrument will prove a great help to the skilled sugar boiler.

5. Say you find that your low-product gives the highest yield at 88·5 per cent. dry matter (Brix or Balling) or say at 11·5 per cent. water. You find now the readings of this strike at your instrument to be say 88—this means a difference of 0·5 per cent. Once this difference is fixed by your chemist you move the screw of the scale 2 so that the exact reading of 88·5 is obtained and you will have the concentration required for further strikes to compare exactly with the result found by your chemist with the pycnometer.

The readings of the Standard Boiling Gauge are only reliable with the machinery in working good order. If the vacuum pumpis defective and if the coils are broken, of course, no exact figures are possible. Taking the vacuum of 62 centimetres as a basis the readings made at a vacuum under or over 62 have to be corrected as follows:—

1. For every centimetre above 62 vacuum deduct 0·1 per cent. Brix from the result obtained.

2. For every centimetre under 62 vacuum add 0·1 per cent. Brix to the result obtained.

GERMANY.

As a consequence of the immense production of the period from August, 1901, to July, 1902, the prices of sugar during the first eight months of 1902 were very low, but in the last months the price of raw sugar rose from 6 to 8 marks per 100 cwts. One cause of this was the anticipated scarcity of the beetroot harvest of 1902 (which turned out to be 18 per cent. better than was expected), and another cause was the expected rise in the general market consequent on the abolition of export bounties and cartels by the Brussels Convention. The present sugar prices, when all these artificial props are removed, can only be remunerative for such sugar manufacturers as are in every respect at the top of the trade. The lowering of the very high home prices, which is expected as the result of the Convention, opens up a prospect of a large increase of production for the home trade. The German Sugar Cartel will be dissolved in September of this year.

The principal consumers of German sugar in 1902 were the United Kingdom, the United States, British North America, the Netherlands, Norway, Switzerland, and Japan. The trade with the United States showed a great decrease, owing to the increased import of Cuban cane sugar, and the decreased demand of Japan is attributed to the rise in the Japanese import duties.

The German export amounted to—

Articles.	1902. Quantity in 1,000 Tons.	1902. Value in £1,000.	1901. Quantity in 1,000 Tons.	1901. Value in £1,000.	1900. Quantity in 1,000 Tons.	1900. Value in £1,000.
Raw sugar	495*	3,020	473	3,385	563	5,559
Sugar in loaves	552	5,658	594	6,090	425	5,049
Other kinds	26	274	21	214	17	202

The export was distributed as follows:—

Country.	Raw Sugar. 1902.	1901.	1900.	Sugar in Loaves. 1902.	1901.	1900.
	Quantity in 1,000 Tons.					
United Kingdom	273	239	164	406	443	346
British North America	64	37	21	1·1	0·8	0·2
British South Africa	..	..	..	14	7	0·2
Australia	..	..	..	0·3	2·9	3·7
India	..	..	..	1·4	8·4	3·9
The Netherlands	27	24	16	5	4	3
Norway	..	..	..	26	26	19
Switzerland	..	..	..	24	17	12
United States	87	118	352	1·8	4·8	1·7
Japan	0·5	0·8	1·8	31	54	14
China	2·5	..	..	1·3	0·8	0·2
Argentina	..	..	..	3	..	..
Uruguay	..	..	..	2	0·3	0·2

* The total value for 1902 is lowered.

Greece.

The Cyclades.—British sugar is, of course, out of the question for the present, Austria-Hungary controls the market with her facilities in this bounty-fed article, a surplus stock of which the traders in this district laid in, fearing a rise in price after the ratification of the Brussels Sugar Convention. About 10,000 sacks were lately imported at a price averaging 8s. 10d. per cwt. c.i.f. Syra.

Netherlands.

Imports of beet sugar from Belgium and Germany were considerably larger in 1902 than in the previous year, and prices in the earlier months were greatly depressed, falling as low as 6s. 0½d. per cwt. in the month of June. The Brussels Sugar Convention did not do much to enliven the market, but towards the end of the year the prospect of a diminished crop of beet caused an advance to about 8s. 2⅗d., and prices closed at about 8s. in December.

Imports:—

	1902. Tons.	1901. Tons.	Average last 5 years. Tons.
Sugar, raw	108,442	112,436	99,575
,, other	64,155	62,043	61,312

Exports:—

	1902. Tons.	1901. Tons.	Average last 5 years. Tons.
Sugar, raw	91,141	32,576	61,395
,, other	163,283	195,575	173,254

Exports to United Kingdom:—

	1902. Cwts.	1901. Cwts.	Average last 5 years. Cwts.
Refined	2,388,866	2,864,727	2,534,198
Unrefined	336,765	372,304	436,688

Somaliland.

91,717 rs. worth of sugar was imported during the year, showing a decrease of 3,845 rs. as compared with the previous year's figures, but an increase of 4,240 rs. over the figures of 1899-1900.

United States.

Boston.—The value of imports and exports during the past three years were as follows:—

Exports.—

	1902. £	1901. £	1900. £
Sugar and molasses	48,501	37,155	59,500

Imports.—

	1902. £	1901. £	1900. £
Sugar, beet	20,949	307,016	—
,, cane	1,209,879	1,383,308	—
,, other kinds	14,697	15,862	1,630,218

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. Thompson, C.E., F.C.S., M.I.M.E., Chartered Patent Agent, 6, Lord Street, Liverpool; and 322, High Holborn, London.

ENGLISH.—APPLICATIONS.

5439. C. Steffen, London. *Improved pressing process of obtaining pure concentrated beet root expressed juices and expressed residues rich in sugar.* 9th March, 1903. Complete specification.

5829. J. McNeil, Glasgow. *Improvements in and connected with sugar cane mills.* 13th March, 1903.

6525. B. J. B. Mills, London. (Communicated by Henri Berbier, France.) *The manufacture of saccharin.* 20th March, 1903.

6766. J. Hargreaves, Farnworth-in-Widnes. *Improvements in concentrating and evaporating frothy, viscous, syrupy, and other solutions, and in apparatus for effecting the same.* 24th March, 1903.

7998. S. Stein and C. J. Crosfield, Liverpool. *Improvements in or connected with the manufacture and refining of beet, cane, and other sugars.* Complete specification, 7th April, 1903.

8011. J. McNeil, Glasgow. *Improvements in sugar cane mills.* Complete specification, 7th April, 1903.

9078. F. Meyer, London (communicated by John William Meyer and James Wardrop, Arbuckle, Trinidad). *An improved means of evaporation for the concentration or condensation of syrups or similar fluids.* Complete specification, 22nd April, 1903.

9322. B. J. B. Mills, London (communicated by Henri Barbier, France). *Improvements in the manufacture of saccharin.* Complete specification, 24th April, 1903.

10062. E. P. A. Caille, London. *A new or improved means for refining sugar by cold running-off and its crystallisation by dropping.* 4th May, 1903.

10340. E. Shaw, London. *Improvements in the treatment or preparation of sugar and in machinery or apparatus for use therein.* 6th May, 1903.

ABRIDGMENT.

21454. J. V. P. Lagrange, France. *A new or improved process for the extraction and instantaneous crystallisation of sugar from any syrup, in free air and by refrigeration, in sugar factories and refineries.* 2nd October, 1902. The characteristic feature of this discovery is the instantaneous crystallization, in free air, of the sugar in a supersaturated syrup, under the combined action of refrigeration obtained by means of a current of cold water, and of the disturbance of the crystallization by the agitation of the mass, with the important consequence that the cuite en grains (or the process in which the crystallization commences during the boiling) in the vacuum is avoided, and that of the building containing the storing vessels. This

gives results superior to the ordinary processes, effects a notable economy of fuel, and enables the weight of the molasses to be largely diminished.

8685. J. ROBIN-LANGLOIS, Paris, France. *Improved method of and apparatus for rapidly refining white sugars.* 14th April, 1902. This invention has for object to treat white sugars directly and in a rational manner. The process in principle consists in using under particular conditions, a boiling apparatus and a mixer, and in combining the action of these two apparatus so as to produce a "masse-cuite" quite different from that customary in ordinary refinery. The first has for object to create grains in a medium as cold as possible and alkalined, this medium remaining as fluid as possible, and the second by mixing and cooling more or less slowly has for its object to impart to the mass the richness of a "masse-cuite" with this difference that this latter is fairly fluid so as to be cleared in ordinary turbines, known as centrifugals.

GERMAN.—ABRIDGMENTS.

137694. FRIEDRICH WILHELM RICHTER, of Bergen-op-Zoom-Holland. *A gas distribution pipe for saturation apparatus.* 28th December, 1901. The pipe is provided with slots for the escape of the gas or carbonic acid, and in order to keep these slots free from deposits, a revoluble spindle passes through the pipe, said spindle being provided with cutters, which engage in the slots.

139828. H. PUTSCH & Co., of Haagen, Westphalia. *Double knife-box for shredding machines.* 20th February, 1901. (Patent of addition to Patents Nos. 129029 and 139827, of the 8th June, 1900, and 18th December, 1900 respectively.) In Patent No. 139827, means for supporting the beetroots are arranged in front of the cutting edge of the rear knife of the cover ribs situated on the knife carrying bar of the front knife. These supporting surfaces are carried over the entire width of the knife carrying bar, in order to shorten the space required for freely supporting the roots.

IMPORTS AND EXPORTS OF SUGAR (UNITED KINGDOM)

To end of April, 1902 and 1903.

IMPORTS.

Raw Sugars.	Quantities. 1902.	Quantities. 1903.	Values. 1902.	Values. 1903.
	Cwts.	Cwts.	£	£
Germany	3,184,207	1,239,725	1,130,190	492,684
Holland	181,812	104,359	59,834	39,233
Belgium	338,701	307,758	124,361	126,691
France	1,328,816	134,349	528,186	62,432
Austria-Hungary	52,515	1,066,414	18,036	447,168
Java	....	....	....	....
Philippine Islands	....	70,646	....	25,285
Peru	58.219	64,922	19,880	24,488
Brazil	204,601	40,538	67,971	15,882
Argentine Republic	488,912	72,515	183,300	32,330
Mauritius	122,241	162,036	44,465	57, 92
British East Indies	26,513	57,366	12,643	21,804
Br. W. Indies, Guiana, &c.	447,563	219,830	287,200	140,355
Other Countries	68,496	104,226	28,928	44,670
Total Raw Sugars	6,502,596	3,644,684	2,504,994	1,530,123
Refined Sugars.				
Germany	6,234,868	4,120,743	3,319,160	2,126,654
Holland	1,105,814	641,978	646,163	371,795
Belgium	88,752	52,875	52,687	31,640
France	1,749,106	259,369	898,510	152,511
Other Countries	9,503	361,439	4,479	179,107
Total Refined Sugars	9,188,043	5,436,404	4,920,999	2,861,707
Molasses	394,495	508,928	83,942	96,429
Total Imports	16,085,134	9,590,016	7,509,935	4,488,259

EXPORTS.

British Refined Sugars.	Cwts.	Cwts.	£	£
Sweden and Norway	16,097	7,164	9,519	3,787
Denmark	50,032	26,515	26,984	13,746
Holland	19,924	19,521	10,426	10,604
Belgium	3,028	2,813	1,599	1,372
Portugal, Azores, &c.	3,607	2,119	1,957	1,164
Italy	8,826	3,602	4,276	1,631
Other Countries	109,363	154,489	70,786	93,629
	210,877	216,223	125,547	125,933
Foreign & Colonial Sugars.				
Refined and Candy	11,406	8,137	7,440	5,401
Unrefined	21,650	15,283	11,243	7,943
Molasses	1,091	174	345	76
Total Exports	243,934	239,817	144,575	139,353

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1903. Tons.		1902. Tons.
Total Receipts, 1st Jan. to May 14th ..	636,529	..	539,585
Receipts of Refined ,, ,, ,, ..	341	..	4,172
Deliveries ,, ,, ,, ..	579,414	..	527,082
Consumption (4 Ports, Exports deducted) since 1st January	519,704	..	539,777
Importers' Stocks (4 Ports) May 13th ..	61,500	..	37,814
Total Stocks, May 27th	284,000	..	146,118
Stocks in Cuba ,, ...	359,000	..	444,402
	1902.		1901.
Total Consumption for twelve months ..	2,566,108	..	2,372,316

CUBA.

STATEMENT OF EXPORTS AND STOCKS OF SUGAR, 1902 AND 1903.

(Tons of 2,240lbs.)	1902. Tons.		1903. Tons.
Exports	116,481	..	342,395
Stocks	492,288	..	398,442
	658,769	..	740,837
Local Consumption (four months)	14,050	..	14,880
	672,819		755,717
Stock on 1st January	19,873	..	42,530
Receipts at Ports up to 30th April ..	652,946	..	713,187

J. GUMA.—F. MEJER.

Havana, 30th April, 1903.

UNITED KINGDOM.

STATEMENT OF IMPORTS, EXPORTS, AND CONSUMPTION FOR THREE YEARS.
From *Produce Markets' Review.*

SUGAR.	Imports. 1903. Tons.		Imports. 1902. Tons.		Imports. 1901. Tons.	Exports (Foreign). 1903. Tons.		Exports (Foreign). 1902. Tons.		Exports (Foreign). 1901. Tons.
Refined, Jan. 1st to April 30th	65,455	..	63,179	..	163,035	133	..	149	..	302
Raw, ,, ,,	35,854	..	40,371	..	85,890	262	..	282	..	288
Molasses, ,, ,,	5,648	..	4,133	..	8,715	7	..	13	..	1,107
Total	106,957	..	107,683	..	257,640	402	..	444	..	1,697

HOME CONSUMPTION.	1903. Tons.		1902. Tons.		1901 Tons.
Refined, Jan. 1st to April 30th	58,530	....	64,570	....	—
Raw, ,, ,, ...	38,356	....	39,045	....	—
Molasses, ,, ,, ...	8,159	....	6,021	....	—
Total	105,045	....	109,636	....	—
Less Exports of British Refined	2,684	....	2,234	....	—
Net Home Consumption of Sugar	102,361	....	107,402	....	210,069*

* Trade estimate.

STOCKS OF SUGAR IN EUROPE AT UNEVEN DATES, MAY 1ST TO 27TH, COMPARED WITH PREVIOUS YEARS.

IN THOUSANDS OF TONS, TO THE NEAREST THOUSAND.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	TOTAL 1903.
102	1048	668	422	224	2465

	1902.	1901.	1900.	1899.
Totals	2587 ..	1810 ..	1674 ..	1754

TWELVE MONTHS' CONSUMPTION OF SUGAR IN EUROPE FOR THREE YEARS, ENDING APRIL 30TH, IN THOUSANDS OF TONS.

Great Britain.	Germany	France.	Austria.	Holland, Belgium, &c.	Total 1902-03.	Total 1901-02.	Total. 1900-01.
1475	880	561	412	521	3850	4107	4306

ESTIMATED CROP OF BEETROOT SUGAR ON THE CONTINENT OF EUROPE FOR THE CURRENT CAMPAIGN, COMPARED WITH THE ACTUAL CROP OF THE THREE PREVIOUS CAMPAIGNS.

(From Licht's Monthly Circular.)

	1902-1903. Tons.	1901-1902. Tons.	1900-1901. Tons.	1899-1900. Tons.
Germany	1,750,000 ..	2,304,924 ..	1,984,186 ..	1,798,631
Austria	1,070,000 ..	1,302,038 ..	1,094,043 ..	1,108,007
France	890,000 ..	1,183,420 ..	1,170,332 ..	977,850
Russia	1,215,000 ..	1,098,983 ..	918,838 ..	905,737
Belgium	230,000 ..	334,960 ..	393,119 ..	302,865
Holland	105,000 ..	203,172 ..	178,081 ..	171,029
Other Countries.	345,000 ..	393,236 ..	367,919 ..	253,929
	5,605,000	6,820,733	6,046,518	5,518,048

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Molascuit.

The untiring energy of Mr. George Hughes, the patentee of "molascuit," backed by the active support of the West India Committee, in the effort to get the excise duty on that cattle food remitted, has met with early success. The Chancellor of the Exchequer, in his speech on the Finance Bill, announced his intention of remitting all duty on such commodities that had less than 50 per cent. of sweetening matter in them. Any molasses arriving in that condition in this country would be very dilute, and probably be in a state of active fermentation. Hence no evasion of the duty is likely in the case of molasses alone. But as regards molascuit, the new arrangement will be of great benefit. This commodity consists, so to say, of molasses diluted with digestible megass meal, and as the percentage of sweetening matter in the whole is under 50 per cent., no duty will be incurred by importing it into this country. As a consequence, we may expect in the near future a larger supply of this excellent cattle food. Mr. George Hughes is certainly to be congratulated on the result of his efforts.

Bounties and the Price of Sugar.

Mr. George Martineau, C.B., has another article on the sugar bounties in the June *New Liberal Review*. He takes as his text the oft-repeated assertion that "the abolition of bounties will increase the cost of sugar to the British consumer to the extent of £8,000,000 per annum," and then proceeds to demolish the same with arguments,

which, if we have had them in substance before, are served up in a fresh and perhaps more lucid style. With the conciseness of a Scotch minister, he divides his paper under five headings. In the first, "Rise from what?" he shows that this question has never been answered by those who make the above assertion. In a short table added it is shown what great fluctuations have occurred in the price of sugar since 1884. It was 27s. in 1889, thanks to a deficient beetroot crop, and last year, owing to a large over-production, 2s. to 3s. below the present cost of production. It was clear such a price could not be maintained for long; in fact it rose soon after, owing to the reduction in production which naturally followed. The abolition of bounties would, of course, restore sugar to its natural price, which must be governed by the cost of production. Mr. Martineau concludes this part with the remark that "The assertion that the abolition of bounties will raise the price of sugar must, therefore, be dealt with from a wider point of view than that afforded by the present exceptional condition of the sugar market."

Mr. Martineau next deals with "The Main Fallacy." This is in effect the assertion that the seller who receives a bounty gives the whole of it to the buyer. He had supposed that to any commercial man such a contention would be too absurd to require any refutation; but he finds three statesmen adopting that view, and therefore feels it incumbent to point out, as Mr. Platt-Higgins did some time ago, that "all sellers, whether bounty fed or not, sell at the same market price, and that if one desires to undersell another he does so by the smallest fraction necessary to turn the scale in his favour."

"The only true standard of price" is that based on the cost of production, and this is lower than the average price of the last twenty years. Now, in the assertion that the abolition of bounties will raise the price of sugar, the only sense, writes Mr. Martineau, in which such an assertion can be dealt with is by assuming that the *average* price will be raised. But this, as shown above, is higher than the price based on the cost of production.

"What the confectioners really desire" is that the present conditions, viz., prices 2s. or 3s. below the cost of production, should go on for ever, so as to enable them to continue making large products. Such a state of affairs is impossible. A continuance of bounties would bring about a reduced supply of sugar and a foreign monopoly in a very short time, with a consequential rise in the prices. The confectioners in effect demand that foreign producers should be permanently protected in British markets, in order that British confectioners may always have sugar below its cost of production.

Mr. Martineau's parting shot is for the Cobden Club. He shows how that institution has been clinging to the fallacy about the £8,000,000. First we have the Club itself asserting that the abolition of bounties will *cost* the British consumer that sum.

Then Mr. Harold Cox, its secretary, goes one step more definite by stating that the *gain* to the British consumer by foreign bounties is at least £7,500,000 per annum. Then, when the Club and its secretary are brought to book, they commence to flounder. Here are two statements from Mr. Cox: "I entirely agree that it is a mistake to assume that the advantage of foreign bounties to this country can be measured simply by the sum of money paid by different foreign Governments in the shape of export bounties." "At any given moment it is impossible to determine the precise effect of bounties on price." And yet he asserts that there is a *gain* to the British consumer of at least seven and a half millions!

Mr. Martineau next proceeds to show up the floundering of Sir William Harcourt in the House of Commons. "Again we have two statements even in one speech quite as contradictory as the conflicting declarations of the Cobden Club or its secretary. The price of sugar is to be so raised so enormously that the West Indian planters will make gigantic profits, and yet the assumption that the price is to be raised 'in a manner which will repair the losses of the West Indies' is not well founded."

In conclusion, Mr. Martineau asks: How are we to place any confidence in the declarations of our leading statesmen or of our recognised guides to economic truth when we find such want of efficiency in those high places?

The Brussels Commission.

The Permanent Commission of the Brussels Sugar Convention met at Brussels on the 2nd June. As it was decided that the deliberations should take place in secret, the press were excluded, and no official report of the proceedings has so far been forthcoming. But, as is usually the case, information of a more or less reliable nature has leaked out, and there is good reason for supposing that things have passed off satisfactorily. The Commission first examined the sugar legislation of Roumania; then that of Japan, of Germany, of Luxemburg, and of Belgium. The German and Belgian systems were approved. But the *pièce de resistance* was the question of the Austro-Hungarian *contingent*. The British, French, Dutch, and Belgian delegates voted against it, it being thus rejected by the majority, as against the provisions of the Convention. As a consequence the Commission shortly afterwards adjourned in order to allow the Austro-Hungarian delegates to confer with their respective Governments. They are expected to re-assemble about the 7th instant. It is difficult to see how the Austro-Hungarian Government can insist on retaining its proposed legislation in the face of this opposition.

THE QUESTION OF BRITISH FISCAL REFORM.

The commercial world has lately been considerably stirred by the suggestion put forward by Mr. Chamberlain that the time has now fully come for considering whether Britain's fiscal policy, which has held sway for some fifty years past, is not in need of modification to suit the altered conditions of present day trade, and, *inter alia*, render a closer bond of union between the colonies and the mother country possible.

In the main, Mr. Chamberlain has only propounded a principle, which he suggests that the country should seriously consider and discuss. He will doubtless be prepared to follow it up with a plan when the Government have concluded their investigations and when the country is ripe to receive it. Yet already the ultra-radical and "Little Englander" press are denouncing his scheme with a vehemence that was not surpassed even when the same organs were discussing the Education Bill. One is at a loss to understand the hysterical vapourings of this section of the press. They rear their fetish on high, and try to shout down any threatened opposition, like the silversmiths of Ephesus did. They can see only two alternatives: unlimited free trade, as the Cobden Club define it; and out and out protection, as practised in the United States. No third alternative, a modification of the other two, a sort of "happy medium," will they allow as possible. They even object to steps being taken to discover one; but we doubt whether such an attitude will appeal to the majority of their countrymen. We have heard a good deal lately about the "fetish of free trade." There seems to be another fetish, too, that of Cobden and his fellow economists. For one thing, present day authorities are divided in opinion as to what Cobden's views in some aspects of trade really were. The two parties, free traders and fair traders, each claim him as their man. There is no doubt, however, as to one or two facts. Cobden believed in free trade as a means to the end, not as an inviolate principle. He likewise drew up his code on the supposition that other countries had only to be made acquainted with his free-trade principles when they would accept them with open arms. International free trade in exports and imports was his dream; but history has shown how erroneous his hopes were. His original disciple is now the only one, and the only part of his dream that we have realised is free trade for imports. All the other nations have repudiated his views and fenced themselves in with a protective tariff; and when we consider the undeniable success which has attended their policy, we may well ask ourselves whether the principles governing it are not at least as worthy of consideration for our times, as were Cobden's for his. Already many hold the opinion now that had Cobden foreseen what was going to happen, he would not have followed the line he did; he would have been shrewd enough to have seen that a free-trade

England opposed by a protectionist world was not an ideal state of affairs. But apart from all this wrangling as to what Cobden did, or did not, say, or as to what he would, or would not, have done, had he been alive to-day, one might venture to ask what have Cobden, or Adam Smith, or John Bright, really got to do with present-day trade economics. Granted they were the clever men they were acknowledged to be, yet was a special dispensation given them, such as enabled them to define an ideal system of trade suited not only for their own time, but for all future times, quite apart from any variation in the governing conditions? Are not other equally clever men capable of arising who could deal with the trade requirements, holding in their own day in a more thorough manner than Cobden could have done looking into the unknown future?

Without wishing to discount Cobden's abilities and genius, there is no need to place him on a pinnacle of infallibility, especially a regards the practical application of the principles he propounded; and we think that the British working man will pay more attention to hard facts relating to our present commercial status rather than to theories of the economists of fifty years or more ago. He will not bother his head with theoretical economics, but he will think a good deal of facts adduced to prove that many branches of his trade are passing out of his hands into those of the foreigner; in some cases through the latter obtaining protection for his goods in British markets. That British trade is losing ground in many industries is abundantly clear. The silk and chemical trades have almost gone over to Germany. The boot and shoe industry also is threatened by American competition, though this is partly through the retention of obsolete machinery on our part. The exports of woollen goods have fallen 50% in a short while. Yet the free traders merely suggest that where we are outclassed in one industry, we should turn and devote our energies to another! A more puerile proposition it would be hard to find. If it were followed to its ultimate conclusion, we should in time find ourselves all colliers—and confectioners. That our figures of export have not fallen more in recent years is largely due to increased exports of coal; but as the latter is a raw material and cannot be replaced, we are buying our immunity from trade collapse at a pretty high figure. It is not a fair comparison to lump our exports in one sum, without considering each detail. Looked at as a whole, they may suggest prosperity; dissected, they will probably show that in a very large number of industries a steady fall in the exports has occurred in the last ten years. It is superfluous to point out here the well known case of British refining which has so suffered from its foreign rivals getting protection in our own markets.

Mr. Chamberlain's proposals amount to this: that we should see whether our tariff cannot be altered so as to admit closer relations with our colonies—an Imperial Zollverein in short—and that we

should admit the principle of our right to tax foreign imports if the occasion requires. The latter is necessary for the former, as it places in our hands a weapon, which will enable us to counteract any threatened reprisals by foreign countries, should our colonies give us a preference over them which they resented. At present we are as an unarmed man in fighting for the world's trade. Yet, as has been well said, if we armed ourselves, we should have the biggest weapon of the lot. At present we are in the position of admitting manufactured goods free into our country from abroad to compete with our own products. But when our manufacturers send their output abroad, they are met everywhere by a wall of tariffs which in many cases is simply prohibitive. To cite an instance, British sugar machinery manufacturers have hitherto done a large trade with the West Indies, Cuba and Porto Rico included. But once Porto Rico was ceded to the United States, a system of high tariffs was introduced, and now only American machinery can get into the island. Should Cuba be ceded too, the same thing will happen; we shall lose another large market for our engineers. But, while America may be right from her own point of view, it is a question whether she would not be induced to modify her rates if Britain and her Crown colonies were in a position to retaliate by taxing American machinery to a liberal extent. A 25% *ad valorem* tariff on American machinery imported into British Guiana or Barbados would make things wear a different aspect. And the above is only one out of many instances that could be cited to show how British trade continually meets with rebuffs and yet is powerless to retaliate as things now exist.

In any case, this question of fiscal reform is one that will have to be carefully considered if the integrity of the Empire and the prosperity of British trade is to continue to exist. It can no longer be shelved, but must be threshed out, and we shall be much mistaken if the final verdict is not for a more or less complete change in our commercial policy, and that at a not very distant date.

"What happened with respect to the West Indies was this—that the Continental manufacturer, protected in his own market by extravagant duties, was able at his own pleasure, while not interfering with his own profit, to use his surplus product to render the sugar market so uncertain that it was impossible for the West Indian manufacturer, with any security for himself, to buy the most modern machinery, to adopt the most recent inventions, and to put himself what is called abreast of the times. We have, I hope, put an end to that by the Sugar Convention. Supposing it had been the iron and steel industry—supposing some foreign country had used our iron and steel industry as the Continental sugar manufacturer used the West Indian manufacturer, I do not believe that the people of this country would have stood it."—*(Extract from a speech by Mr. A. J. Balfour.)*

THE SUGAR CANE IN EGYPT.

By Walter Tiemann,

Member of the Society of German Sugar Technists and of the Assoc. des Chemistes de Sucreries et Distilleries, Paris.

(Continued from page 294.)

III.

Sugar Cane Experiments, 1899. Field A.

(First Year Canes.)

Manures.

No. 1. Stable manure.
,, 2. Stable manure and bone dust.
,, 3. $(NH_4)_2SO_4$ (400 kg. per hectare, or 180 lbs. per acre) planted with cuttings with 1 node.
,, 4. Ditto ditto ditto .. 3 nodes.
,, 5. Ditto ditto ditto .... 2 ,,
,, 6. Ditto ditto ditto .. 4 ,,
,, 7. Ditto (200 kg. per hectare, or 180 lbs. per acre) and Thomas slag (500 kg. per hectare, or 450 lbs. per acre).
,, 8. Sulphate of potash (200 kg. per hectare, or 180 lbs. per acre).
,, 9. Unmanured.

The Yields obtained were as follows:—

No.	Kg. Cane per Hectare.	Cantars Cane per Feddan.	Lbs. Cane per Acre.
1	62,291	581·3	55,548
2	90,735	846·8	80,913
3	46,871	437·4	41,797
4	81,899	764·3	73,034
5	47,989	447·8	42,794
6	64,456	601·6	57,479
7	67,195	627·1	59,921
8	55,312	516·2	49,324
9	43,484	405·8	38,777

Analyses of Sugar Canes harvested from Field A, 1899.

(First Year Canes.)

No.	Sp. Gr.	Brix.	Baumé.	Sugar in Juice.	Non-Sugar.	Quotient.	Sugar in Cane.	Glucose.	Average Weight per Cane stem. Grams.
1	1·080	19·3	10·9	16·68	2·62	86·4	14·2	0·5	1375
2	1·081	19·5	11·0	16·94	2·56	86·8	14·5	0·5	1480
3 and 4	1·076	18·4	10·4	15·42	2·98	83·8	13·2	0·6	1440
5 and 6	1·077	18·6	10·5	15·92	2·68	85·5	13·6	0·6	1440
7	1·072	17·5	9·7	14·46	2·94	83·0	12·3	0·7	1300
8	1·077	18·4	10·4	15·95	2·54	86·2	13·5	0·6	1210
9	1·080	19·2	10·8	16·79	2·41	87·4	14·3	0·5	1150

The experiment field A was planted with selected cane cuttings, taken from the previous year's experiment field in rows 0·90 m. apart. The unmanured control plots were planted wet after the Arab method with rows 0·70 m. wide. It was desired to make a comparison between stable manure and sulphate of ammonia manures. With that view plots Nos. 3 to 6 were planted with cuttings having different numbers of eye buds whereby the cuttings with three eyes again gave the best results. The experiment fields had been planted from the first year with three-eyed cuttings.

Field B, 1899 (First Year Canes).

Each plot consisted of 1,000 square metres (50 m. × 20m.)

No.	Width of Plant Rows (metres.)	Method of Planting.	Manure.
1^n	0·80	Wet, Arab style	17·5 kg. $(NH_4)_2SO_4$ Per hectare, 175 kg. ,, feddan, 75 ,, ,, acre, 160 lbs.
2^n	1·20	Dry, three-noded cuttings.	
3^n	1·50	,, ,, ,,	
4^n	0·90	,, ,, ,,	
5^n	0·80	,, ,, ,,	
1^s	0·80	,, ,, ,,	Unmanured.
2^s	0·90	,, ,, ,,	
3^s	1·50	,, ,, ,,	
4^s	1·20	,, ,, ,,	
5^s	0·80	,, ,, ,,	

All the plots, 1^n to 5^n, and 1^s to 5^s, were planted with *selected* cuttings.

No.	Width of Plant Rows.	Manure (per Row).
6	0·90	12 kg. $(NH_4)_2SO_4$ (50 kg. per feddan, or 120 kg. per hectare, or 110 lbs. per acre).
7	0·90	Ditto ditto ditto
8	0·90	Ditto ditto ditto
9	0·90	Unmanured.
10	0·90	12 kg. N_aNO_3 + 17·5 kg. $(NH_4)_2SO_4$.
11	0·90	Unmanured.
12	0·90	Unmanured.
13	0·90	Unmanured.
14	0·90	12 kg. N_aNO_3.
15	0·90	Ditto and 35 kg. $(NH_4)_2SO_4$.
16	0·90	Ditto and 17·5 kg. ditto.
17	0·90	20 kg. sulphate of potash and 12 kg. N_aNO_3.
18	0·90	Ditto ditto 25 kg. Thomas slag.
19	0·90	Ditto ditto ditto and 17·5 kg. N_aNO_3.

Crop Yields from Field B, 1899 (First Year Canes).

24 plots of 1,000 square metres.

No.	Kg. Cane per hectare.	Cantars Cane per feddan.	Lbs. per acre.
1^n	75,960	709	67,741
2^n	74,840	694	66,739
3^n	61,840	577	55,146
4^n	78,260	730	69,789
5^n	79,060	737	70,502
1^n to 5^n average	73,992	689	65,983

No.	Kg. Cane per hectare.	Cantars Cane per feddan.	Lbs. per acre.
1^s	70,820	661	63,154
2^s	64,880	605	57,857
3^s	63,280	590	56,430
4^s	64,860	605	57,830
5^s	53,210	496	47,450
1^s to 5^s average	63,410	591	56,544

6 to 8 were used as cuttings for 1900 experiments.

No.	Kg. Cane per hectare.	Cantars Cane per feddan.	Lbs. per acre.
9	60,640	566	54,076
10	80,530	751	71,813
11	55,140	514	40,253
12	54,410	508	48,520
13	59,210	552	52,801
14	75,710	706	67,515
15	84,490	788	75,344
16	76,040	709	67,809
17	69,530	649	62,003
18	75,090	700	66,070
19	80,930	755	72,170
9 to 19, average	70,156	654	61,670

Analyses of Experiment Field B, 1899.

(First Year Canes.)

No.	Sp. Gr.	Brix.	Baumé.	Sugar in Juices.	Non-Sugar.	Quotient of Purity.	Sugar in Cane.	Glucose.	Average Weight of Single Canes. Gr.
1^n	1·066	16·0	9·0	12·88	3·1	80·5	10·8	0·8	1255
2^n	1·073	17·7	10·0	14·91	2·7	84·2	12 8	0·7	1644
3^n	1·072	17·4	9·8	14·38	3·0	82·6	12·3	0·7	1400
4^n	1·067	16·2	9·2	12·86	3·3	79·3	11·0	0·8	1250
5^n	1·070	17·1	9 7	14·22	2·8	83·1	12·2	0·7	1518

Average content in sugar of canes from No. 1^n to 5^n = 11·8 per cent.

No.	Sp. Gr.	Brix.	Baumé.	Sugar in Juices.	Non-Sugar.	Quotient of Purity.	Sugar in Cane.	Glucose.	Average Weight of Single Canes. Gr.
1s	1·071	17·3	9·8	14·44	2·8	83·5	12·4	0·6	1244
2s	1·071	17·2	9·7	13·88	3·3	80·7	11·7	0·8	1555
3s	1·064	15·7	8·9	12 35	3·3	78·7	10·4	1·0	1350
4s	1·070	17·1	9·7	14·41	2·6	84·2	12·3	0·6	1190
5s	1·064	15·7	8·9	12·11	3·5	77·1	10·3	0·9	1040

Average content in sugar of canes from No. 1s to 5s = 11·4 per cent.

6	1·069	16·7	9·4	13·72	2·9	82·8	11·7	0·7	1400
7	1·062	16·3	9·2	12·99	3·3	79·6	11·0	0·8	1500
8	1·069	16·7	9·4	13·69	3·0	81·9	11·6	0·7	1515
9	1·076	18·4	10·4	15·68	2·7	85·2	13·4	0·7	1203
10	1·065	15·9	9·0	12·48	3·4	78·4	10·6	0·8	1410
11	1·070	17·1	9·7	14·54	2·5	85·0	12·4	0·7	1330
12	1·076	18·3	10·3	15·81	2·4	86·3	13·5	0·7	1460
13	1·068	16·6	9·4	14·01	2·5	84·4	12·2	0·6	1522
14	1·065	15·8	8·9	12·29	3·5	77·7	10·4	0·8	960
15	1·070	17·1	9·7	13·82	3·2	80·8	11·8	0·8	1580
16	1·068	16·6	9·4	13·93	2·6	83·9	12·1	0·6	1350
17	1·079	19·1	10·8	16 81	2·2	88·0	14·4	0·6	1466
18	1·075	18·2	10·3	15·89	2·3	87·3	13·5	0·7	1690
19	1·076	18·3	10·3	15·73	2·5	85·9	13·5	0·7	1750

The best results were achieved on plot No. 2. Stable manure and bone dust which had been one year in process of fermentation were applied. Unfortunately one seldom or never finds in Egypt any preservation or proper preparation of stable dung, it being mostly merely dried to serve as fuel for the fellahs. Sulphate of ammonia had in these experiments, strange to relate, nothing like so good a result as was expected, possibly because of its being washed away during irrigation.

The plots 1n to 5n and 1s to 5s were planted similarly with selected cane cuttings and those situated on the north side (Nos. 1n to 5n) moreover received a nitrogen dressing in the form of sulphate of ammonia (75 kg. per feddan or 160 lbs. per acre). The outward appearance of the whole ten plots was excellent, and their equal was not to be found in any of the surrounding cane fields. As a result of three years' selected planting, the outcome of the experiments was becoming so evidently remarkable that it was a pleasure to visit the plants day by day. The cane had a particularly healthy and strong appearance, good colour, and above all a very even grouping whereas other fields were as irregular as could be imagined, with slender canes of luxuriant shape. The difference between the manured and unmanured rows was similarly very pronounced. The grouping of the manured cane was the better of the two. One could see at a distance that the wholly manured rows overtopped the unmanured

ones by about $2\frac{1}{2}$ feet. The average weight of individual canes was: unmanured, 1275 grams, manured, 1430 grams. The difference in sugar content amounted to 0·4 %. The whole quantitative yield amounted in the manured plots (1^{n} to 5^{n}) to 98 cantars in excess of the unmanured.

These 98 cantars of cane represent at present day prices (where one cantar fetches $2\frac{3}{4}$ piastres $= 2\frac{1}{2}$d.) 269·05 piastres. The outlay for manure was 75 piastres per feddan. With an increased outlay of 75 piastres the writer obtained in the course of one year an increased return of 194·5 piastres per feddan. Some plots yielded even more. On the same plots the writer undertook experiments on the plan mentioned above, with a view to estimating the best width of the rows; widths from 0·80 to 1·50 metres were tried. In the end a width of 0·90 m. was found to be the most advantageous, this distance being the one which had already been used as the standard.

In the plots Nos. 6 to 19, which again were planted in a similar manner with average first year cuttings (unselected), nitrogenous manures were the chief ones used in combination with potash and phosphate. The whole of the 1899 experiment field was laid out on a piece of ground bordering on the desert, which, having been found unsuitable for cane culture since several years had been planted with maize, clover and corn. As it was only a moderately good soil, it lent itself well for experimental purposes, inasmuch as in such a soil the advantages of manuring and good cultivation were more strikingly shown, as the harvest figures proved. From the analyses, again, nothing conclusive can be drawn, as in this year too a night frost arose before the harvest and hindered the full maturing of the canes. Previous to that, it had occurred to the writer to rear a special variety of cane, and plant it sufficiently early. as to enable it to reach full maturity before damage from the eventual night frosts was to be feared. Before the month of December no frosts put in an appearance, so by small experiments the writer proved that whereas long established custom had decreed that planting should not begin before the middle of February, yet an early planting even in the months of December or January was not out of place. If one fears frost in the night, then one can cover the cuttings with leaves and thus protect them from what is after all but a superficial frost. The cold does not penetrate beneath the soil, where it would do damage. It is true the budding and growing is somewhat delayed by the colder weather, but once the warmer weather comes on, the buds more than make up lost time, and finally are far in front in sugar formation of the later planted canes, when from nine to twelve months have elapsed.

The quantitative crop results of Nos. 6 to 19 show that with the employment of nitrogenous manures, such as saltpetre and sulphate of ammonia, a considerable increase is the result. With larger applications of nitrogen the yield is enhanced; yet one must exercise

caution lest any unfavourable results ensue for the sugar content. The second year cane requires more nitrogen than the first year. For first year cane the writer considers an application of 75 to 100 kg. of nitrogen per feddan (175 to 240 kg. per hectar, 160—210 lbs. per acre) as the normal one for the Upper Egyptian soil. The nitrogenous manures must be given sufficiently early; it is best done in two doses—the first on the sprouting up of the canes, and the other about six weeks later. The first dose gives, as observations show, a good body to the canes, and the second further strengthens the young shoots. It follows that one must support and nourish the young plants well during the early period of growth, so that they may feed on the above-mentioned plant nutriments and enable the latter to do their work fully. If the nitrogen is given too late, then the maturing is hindered, and the sugar content remains one or more per cent. behind other canes of the same age. The nitrogen in the form of sulphate of ammonia is only to be given before the planting, as only when it has been transformed in the ground to nitric acid is it directly assimilable. Moreover there is always a danger of it being prematurely washed away during irrigation. In order to correct a mistaken impression it should here be definitely stated that, as is well known, the ammonia is absorbed from the soil, and under the conditions of rain precipitation usually found in Europe cannot be washed away. The conditions are, however, quite otherwise under the irrigation system, and particularly so in the results following a single but voluminous watering. It is therefore wisest to give nitrogen in the form of saltpetre under the rules laid down for that substance.

The plots with potash and phosphate manure showed good sugar contents. In these plots a specially straight and stiff growing cane was observed, and contrasted with the partly storm shattered "nitrogen" canes. A one-sided manuring with either potash or phosphate is not recommended, although these nutriments form the main composition in the leaves and stems. The working of the two foods is first apparent through the nitrogen applications connected with them, inasmuch as the latter facilitates the working of the two former. The best results in sugar content and yield were thus obtained on the above-mentioned experiment rows of plot 19 with full manuring.

FIELD C, 1899 (SECOND YEAR CANES).

MANURE.

Plot. No.	Kg. per Feddan.	Kg. per Hectare.	Lbs. per Acre.
1	75 sulphate of ammonia	178	160
2	75 sulphate of ammonia	178	160
3	85 saltpetre	200	180
4	Unmanured	—	—

Crop Yields of Field C.

No.	Kg. Cane per Hectare.	Cantar Cane per Feddan.	Lbs. Cane per Acre.	Per cent. Increase over Unmanured.
1	53,408	498	47,627	138
2	41,525	387	37,030	85
3	49,958	466	44,550	123
4	22,450	209	20,011	—

Analyses of Field C.

No.	Sp. Gr.	Brix.	Baumé.	Per cent. Sugar in Juice.	Non-Sugar.	Quot'nt.	Per cent. Sugar in Cane.	Per cent. Glucose.	Average Weight per Single Cane Stem (gr.)
1	1·074	17·9	10·1	15·34	2·5	85·7	13·2	0·7	1200
2	1·079	19·1	10·8	16·73	2·3	87·5	14·3	0·3	1434
3	1·079	19·1	10·8	16·52	2·5	86·5	14·1	0·4	1232
4	1·079	19·0	10·7	16·45	2·5	86·5	14·0	0·4	850

The field C, 1899, was again the scene of manurial experiments with second year cane. The progress of these canes always depends very much on the more or less good and careful treatment of the first year cuttings. Field C had also previously been used by the station for first year canes and, having been manured for that purpose, found itself in a normally good condition. The after effects of the Thomas slag and potash, besides nitrogen, given in the previous year, were distinctly noticeable in the second year's nitrogenous manuring. It yielded a firm, strongly growing, cane with a good sugar content. No. 4 was not manured in the previous year, and gave only a small yield, although in sugar content it was equal to the others. Since Nos. 1, 2, and 3 only received nitrogen in the second year, one might have expected these plots to remain behind No. 4 in sugar content and ripeness. That this was not the case is a proof of the after effects of the first year's phosphate of potash manuring. The nitrogen had a good visible effect on this field, and again the saltpetre showed a better financial result than sulphate of ammonia. The latter was, for its first application, ploughed in between the plant rows on the sprouting of the new buds; for the second application it was given as a top dressing. The saltpetre was given in the afore-mentioned manner, being strewed in the rows after a watering. That the nitrogen in sulphate of ammonia has not the same effect on the quantitative yield as the saltpetre is explained by the fact that under the conditions of irrigation in use, a part of it gets lost.

Field Experiments, 1900 (First Year Canes).

Eight plots of 1,000 square metres.

No.	Manure per Feddan.	Kg. Cane per Hectare.	Cantars Cane per Feddan.
1	Unmanured	48,760	454
2	300 kg. Thomas phosphate	54,940	515
3	60 kg. sulphate of potash	53,260	497
4	60 kg. sulphate of potash and 300 kg. Thomas phosphate	59,530	555
5	75 kg. saltpetre	62,400	582
6	75 kg. saltpetre and 300 kg. Thomas phosphate	63,100	588
7	75 kg. saltpetre and 60 kg. sulphate of potash	60,070	560
8	75 kg. saltpetre and 60 kg. sulphate of potash, and 300 kg. Thomas phosphate	66,320	619

No.	Manure per Acre.	Lbs. Cane per Acre.
1	Unmanured	43,482
2	640 lbs. Thomas phosphate	48,904
3	125 lbs. sulphate of potash	47,495
4	125 lbs. sulphate of potash + 640 lbs. Thomas phosphate	53,086
5	160 lbs. saltpetre	55,645
6	160 lbs. saltpetre + 640 lbs. Thomas phosphate	56,269
7	160 lbs. saltpetre + 125 lbs. sulphate of potash	53,567
8	160 lbs. saltpetre + 125 lbs. sulphate of potash + 640 lbs. Thomas phosphate	59,141

Analyses of Field Experiments, 1900.

(First Year Canes.)

No.	Sp. Gr.	Brix.	Baumé.	Sugar in Juice.	Non-Sugar.	Quotient.	Sugar in Cane.	Glucose.	Average Weight of Single Cane Stem.
1	1·074	17·8	10·0	15·98	1·8	89·7	13·2	0·6	1370
2	1·079	19·0	10·7	16·71	2·2	87·1	14·0	0·4	1600
3	1·077	18·5	10·4	16·31	2·1	88·1	13·8	0·6	1470
4	1·077	18·5	10·4	16·24	2·2	87·8	13·8	0·6	1550
5	1·073	17·6	9·9	15·71	1·8	89·2	13·0	0·8	1700
6	1·079	19·4	10·7	16·47	2·5	86·5	13·9	0·5	1700
7	1·078	18·9	10·6	16·28	2·6	86·0	13·7	0·5	1600
8	1·081	19·6	11·1	16·85	2·7	85·9	14·2	0·4	1880

The average yields of second year canes under the customary cultivation adopted by the Fellahs amount to from 140 to 250 cantars of cane per feddan = 13,360 to 23,870 lbs. per acre. By carefully cultivating the first year canes, regulating the irrigation (so as to

prevent the cane being treated like an aquatic plant and flooded, a proceeding which tends greatly to kill off the roots owing to want of acid in the soil), and by a subsequent careful rearing and manuring, an increase of as much as 100 per cent. can, as shown, be easily obtained. The field experiments of 1900 were made on very medium soil on the borders of the desert. If we compare the first four plots with the last four, then the latter show undoubtedly the higher figures, this being in the first place due to the want of nitrogen in the soil. Potash and phosphoric acid had likewise a distinct effect on the weak soil, but are only assimilable when combined with nitrogen, as No. 8 with the highest yield on this field conclusively shows.

DISAPPEARANCE OF REDUCING SUGAR IN SUGAR CANE.

By H. W. Wiley, Washington, U.S.A.

The occurrence of reducing sugar in sugar canes and sorghums has important relations to the metabolism of the plants. Presumably the carbohydrate which is finally formed in the chlorophyl cells of these plants is some variety of starch, probably a soluble variety, since starch granules as such would find obstructions to circulation in the return currents from the leaves to the body of the plant. During the early stages of growth it has been shown by repeated analyses that the proportion of reducing sugar to sucrose in the juices of the sugar cane is very high. In Louisiana where the canes are harvested necessarily before growth is complete, the average quantity of reducing sugars in the juice is one per cent. or more. In the tropics at the time of harvest the percentage of reducing sugars is very much less, usually less than one-half of one per cent. These facts show beyond doubt that the highest relative value of reducing sugar to sucrose is in the earlier stages of growth and the lowest proportion in the matured stages. Theoretically, then we might expect that at a certain period representing the complete and perfect maturity of the plant the reducing sugar would disappear. The further phenomenon, however, has also been observed, namely, when the reducing sugar is reduced to a minimum on approaching maturity any deterioration in the plant due to long standing, over ripeness, injury from frosts or otherwise, tends to reverse the order observed during the growing period, and to increase the percentage of reducing sugar at the expense of the sucrose. This reversibility of enzymic action has been well established in the case of carbohydrates*. If the sugar cane, therefore, be allowed to normally grow and mature there is a certain time in its history, as above mentioned, where the proportion of reducing sugar is at a minimum. The theory above outlined receives

*Jour. Chem. Soc. Trans., May, 1903, p. 578.

confirmation in some analytical data secured in this bureau recently on samples of sugar cane grown in Florida. Four samples were obtained which were all harvested at the same time, namely, the middle of May, 1903. The canes were grown by W. H. Abel, on Terra Ceia Island, Manatee County, Florida, about 150 yards from salt water. The soil is sandy to a depth of from 12 to 18 inches, with a thin stratum of chocolate coloured subsoil resting on clay which carries some pebble phosphate. The particular samples under question were grown on the edge of a field next to timber, and being in the outside row did not get much cultivation and practically no fertilizer. The samples were cut seventeen months from time of planting. The analytical data obtained from the four samples are as follows :—

COMPOSITION OF THE JUICE.

Density. Per cent.	Sucrose. Per cent.	Purity.	Glucose.
21·0	19·0	90·5	None.
20·8	18·7	90·0	None.
20·4	18·0	88·2	None.
21·7	19·8	91·2	None.

These are the only samples of sugar cane ever analysed under my supervision which did not contain a greater or less quantity of reducing sugar. At the end of two minutes boiling of the juices with an alkaline copper solution there was no trace whatever of any reduction. On longer continued boiling and after allowing to stand overnight there was a mere trace of reddish precipitate due doubtless to the inversion of a part of the sucrose. A great many of the canes grown on this field produced tassels, but Mr. Abel did not state in his description whether the four canes sent had tasseled or not. The presumption is that they had. We have in the above what appears to be an example of a complete cycle of growth in the sugar cane, probably a cycle which would not be realised farther south. Evidently the cool nights of the winter had helped to complete the period of growth while at the same time they prevented a beginning of the second growth which would certainly have reversed the metabolic activities within the cane and secured an inversion of a part of the sucrose. It is probable that the meteorological conditions which produced so complete a growth do not often obtain, and the above data are therefore of interest both from a chemical and physiological point of view. The analyses were made in the Sugar Laboratory by Mr. A. W. Bache.

It is announced that Dr. Hager, the energetic editor of the *Deutsche Zuckerindustrie*, has resigned his post, from January next. The German sugar manufacturers will thus lose the services of one of their greatest champions.

Dr. CLAASSEN'S PROCESS OF CRYSTALLISATION.

(Continued from page 284.)

The work of boiling can be divided into two parts; in the first, the boiler proceeds in the ordinary way, in other words, he proceeds by periodical charges of syrup, having nothing to guide him beyond certain determined scales in the variations of the proportion of water in the mother syrup. As soon as the mass has attained the percentage of water requisite for the graining, the hot steam is shut off, and an active circulation is provoked in the apparatus by means of a special process which will be described further on. When a sufficient number of crystals have formed themselves, the mass is at once diluted by introducing a fresh charge so as to raise the percentage in water to the value indicated by the preceding column of the table which is about $\frac{3}{4}$ to 1 % higher. If, for example, a syrup has a purity of 75, the graining is done according to column *b*; after graining, one lowers the supersaturation to the value indicated by column *a*, then one boils in the ordinary manner keeping for one hour according to column *a*. At each fresh charge one dilutes the mother syrup with a quantity of water equal to about $\frac{1}{4}$%. One passes little by little to the following column *b*, staying about three hours under that column as with each of the following columns up to *e* inclusive. One arranges before passing to column *f* that the boiling apparatus should be nearly if not quite full.

In the ordinary method, one presses the masse-cuite gently, a a proceeding which never lasts long, and then lets it cool. In the Claassen process a second period of boiling commences here, which one can call the period of crystallisation in motion properly speaking. From this moment in short the boiling apparatus in fact is no more than a crystalliser. One of the most rational applications of crystallisation in motion is certainly that which has been called "boiling crystallizers," such as that of Huch, where the masse-cuite continues to crystallize in vacuo and where a heating apparatus permits the regulation of temperature and the concentration of the mother syrup according to the requirements of the crystallisation. The Claassen process without employing so complex an apparatus, realizes the same advantages with its boiling apparatus with still more, at all events more certain, success.

The action then is to provoke in the boiling apparatus within a relatively short space of time a desugarizing of the syrup sufficiently complete as to obtain with certainty in the end a strongly purified molasses-running. The principal condition to ensure this is always the maintenance of a light supersaturation of the mother syrup; but this condition is always very difficult to realise; for, on the one hand, the masse-cuite ought to receive a certain amount of heat to replace

that lost continuously by evaporation and by radiation; now if one introduces hot steam in a continuous stream, however feeble in quantity, the loss of water by boiling is always too high; the crystallisation does not take place quick enough as to enable it to keep pace with the progressive concentration of the syrup. One consequently obtains very quickly an increase in the supersaturation, the influence of which on the viscosity of the running is not sufficiently counteracted by the increase in the boiling point; the process of crystallisation thus slackens more and more. On the other hand, the more the masse-cuite loses its fluidity the more difficult circulation becomes; the running in all parts of the apparatus no longer maintains an equal temperature and concentration; neither is the supersaturation any longer uniform.

The means chosen by Dr. Claassen for obviating this double inconvenience, and which represented the first of his patents, is the direct introduction into the masse-cuite of dry steam at a higher temperature than that existing in the apparatus. A perforated spiral pipe traverses the boiling pan in its lower part, just underneath the combustion chamber of heating tubes like those found in vertical evaporating apparatuses. When the valve for the steam heater is closed, and that for injecting steam is opened to the desired amount, one can then leave the masse-cuite for several hours by itself, without, in fact, either the temperature or the concentration of the running undergoing any appreciable alteration, providing the vacuum remains the same. In short, the steam introduced into the apparatus quits it at a temperature corresponding to the vacuum existing there and yields to the masse-cuite the greater part of the calories which it possessed at the higher temperature. This light acquisition of heat on the part of the masse-cuite does no more than compensate for the ordinary loss by radiation. A certain part of the steam doubtless condenses from the the first on contact with the masse-cuite; but as the latter is always at the point of ebullition or at a temperature very adjacent to that, this condensation produces as well a corresponding ebullition. The small quantity of water evaporated constantly on the free surface of the masse-cuite is negligible in practice, besides being compensated for to a greater or lesser extent by the slight excess of condensed water which is not evaporated afresh. But the principle rôle of this steam injection is to provoke by expansion a strong circulation in the masse possibly better than that obtained by the most ingenious arrangements of heating surface. This direct introduction of steam into the masse-cuite has thus for an object the realizing in the boiling apparatus the same crystallization in motion as is obtained in special crystallizers, with the advantages of greater compactness and more economy.

A vertical stirrer, with straight horizontal arms is moreover placed in the apparatus and works constantly. The boiler after having filled

his apparatus, continues for some ten or fifteen hours to stir the masse-cuite, whilst introducing at even intervals a little steam into the heating chamber in order to compress the masse little by little and so bring it to its final concentration.

The concentration should extend to from $8\frac{1}{2}$ to 8% of water in the running. This possesses at its maximum a purity of 68.

In calculating the co-efficient of supersaturation, the following formula is of use:—

$$E = \frac{q}{S_t + C\,x + 0{\cdot}01\,q}$$

where E stands for the percentage of water in the running, q the quotient of purity of the running; S_t, the figure which indicates the relation of the solubility of pure solutions at the temperature *t*; C, the coefficient of saturation of the running; and x, the desired coefficient of supersaturation. Granting the masse-cuite immediately before cooling possesses a temperature of 90, the running of 68 purity and 8% of water has a supersaturation of:—

$$8 = \frac{68}{4{\cdot}15 + 1{\cdot}3x + 0{\cdot}68}$$

from which we find $x = 1{\cdot}45$, or 1·35 in the case of 8·5% of water.

There was need to condense the masse-cuite to this point especially towards the end, so as to relatively hasten the crystallisation; but in the crystallizer where the temperature falls and the circulation of the crystals is much slower than in the boiling pan, the viscosity produced by such a high coefficient of supersaturation offers two great obstacles to the success of the crystallisation. It is therefore advantageous to diminish the concentration down to a coefficient of 1·20 at most; so before cooling the masse-cuite, one dilutes it with hot water to the requisite concentration. The engineering firm responsible for the installation of the process and who have obtained exclusive right to all the patents of Claassen in Germany, Belgium, &c., the well-known Maschinenfabrik Grevenbroich, themselves recommended lately a proportion in water of 10%, which under the preceding conditions corresponds to a coefficient of supersaturation of about 1·15. In this case, if the running has 8·5% of water and the masse 80 of purity, it will be necessary to add to a masse-cuite of 35,000 kilos about 380 litres of water. This addition of water, instead of taking place in the boiling pan itself, might be carried out with perhaps more certainty, in the crystalliser at the moment of cooling.

The crystallisers supplied by the Grevenbroich establishment and which form a necessary part of the installation for the Claassen process are merely Bock apparatuses surrounded on their cylindrical periphery by a double jacket, and fitted with a stirrer of special design.

The movement of the masse-cuite in the crystallisers has no other object than to ensure to the same a uniform temperature and

concentration, and since we are acquainted with the chief rôle in the crystallisation process of the supersaturation of the mother syrup, which depends exclusively on these two factors, we are better able to appreciate generally the advantages of the crystallisation in motion. But, as we have seen, it is not sufficient to regulate in the masse-cuite a certain supersaturation, provided it be uniform; it is desirable, in order to ensure a regular and rapid crystallisation, for that supersaturation to be as low as possible. In the crystallizers we observe at the cooling period a supersaturation of 1·20 or even better still of 1·15; this latter is never increased in consequence, on the contrary, one can let it fall progressively to 1·05. Any further fall, to 1, is of no advantage, as the crystallisation is then rendered too slow.

The necessary consequence, for keeping up this feeble supersaturation of the mother syrup in proportion to the crystallisation, is the artificial augmentation of the proportion of water in the masse-cuite. In short, in the same time that the temperature falls and that the purity of the running is lowered, the supersaturation of the latter, in the case of a constant proportion of water in the masse-cuite, goes on steadily increasing. If we consider the formula:—

$$E = \frac{q}{S_t\, C\, x + 0{\cdot}01\, q}$$

(in which C is the coefficient of supersaturation), we see that in the same time that the factor q diminishes, the factor S_t decreases likewise, but to a much more considerable extent (it is 4·15 at 90 and 2·5 at 45); C increases in principle with the diminution in the quotient of purity and decreases while the temperature is falling, in such a manner that it is slightly more feeble at the end than at the commencement, being 1·2 in round figures instead of 1·3. If on the other hand C ought to remain the same or else become smaller towards the end, it follows that the value of E must increase, and the latter should doubtless increase in the same measure in which the syrup loses sugar by crystallising out, but it never does so sufficiently as to compensate for the variation in the other factors. A syrup of 68 purity and having 10% of water which desugarizes so far as to have a purity of no more than 60, reveals in its final composition 12·2% of water. On the other hand, the amount of water which in a running of 60 purity and at 45, corresponds to a supersaturation coefficient of 1·05 is about 15·8%. Thus, for the same masse-cuite as formerly, according to its purity, one has to add to the crystallisers a quantity of water which may vary from 500 to 900 litres or more. This quantity of water is given for simplicity's sake in portions at the rate of 1·5 to 3·5 litres per cubic metre of masse-cuite (according to the latest recommendations) at the first moment following the cooling in the malaxeurs; the period of time between two consecutive portions corresponds to a fall in temperature of 4 or 5 degrees. By this method the coefficient of supersaturation remains at the desired level. The patents provide for

the employment of sugar solutions or diluted runnings; but in practice Dr. Claassen prefers and recommends water at a temperature in the vicinity of that of the masse-cuite. This introduction of water into the malaxeurs does not require any special apparatus, such as perforated pipes, &c., it is done simply by means of a small cock which runs direct into the malaxeur. The water, though it may be very hot, glides over the surface of a masse-cuite both concentrated and viscous, and is but slowly mixed with the supersaturated running by means of the arms of the agitator; there is thus no fear of the crystals dissolving. This replacement of runnings, or more or less diluted molasses, by pure water is an extremely simple idea, but not in sum, the least original of the whole process. The masse-cuite is allowed to cool by itself; at the end of four days, if the surrounding temperature was what it ought to be, the temperature in the crystallisers should have fallen to 45 or 50; centrifugalling should then follow, any further duration of the crystallisation not being economical owing to the viscosity of the runnings, which increase enormously at this temperature.

The method of crystallisation according to Claassen comprises, then, three principal novelties; first, the employment of a controlling apparatus constructed on entirely scientific lines, and constituting in itself an instrument of remarkable power in the hands of a simple workman. Thanks to this apparatus, the boiling becomes the easiest job in the world, and can be placed in the hands of an inexperienced newcomer providing he is intelligent and conscientious. Secondly, the introduction of steam direct into the masse-cuite. This proceeding (which solves, in a manner both ingenious and practical, the burning question with regard to circulation in the masse-cuite) constitutes simultaneously one of the best applications of the principle of crystallisation in motion. Thirdly, the dilution of the masse-cuite at the moment of cooling and in the crystallizers by means of water.

These three innovations together form (apart from the manufacture being the least complicated in the world, indeed, it simplifies matters a great deal) an ideal method of crystallisation, for all three combine to realise by the sole act of the regulation of the percentage of water in the runnings the theoretic conditions of the best crystallisation possible, and the maintenance during the whole process of crystallisation of the smallest supersaturation of the mother syrup compatible with the purity of the latter.

Some details are given of the results obtained by means of the Claassen process during the last campaign on a foreign factory which transformed, in course of manufacture, all the sugar of the beets into refined, for nearly half, and into crystallized. The plan of work adopted comprised two strikes only, without remelting and without any other "returns" than those made at the first boiling of green

refinery syrups and of a part of the rich runnings in the manufacture of crystallized. As an exceptional case, a special boiling of the last running alone was carried out, being a departure from the proposed plan which could have been obviated by slight modifications in the installation. The purity of the virgin syrups was about 92 on the average. The remainder of the runnings, which were never returned to the first boiling, were boiled to grain according to the Claassen formula. The duration of the boiling of the seconds was from 24 to 30 hours.

The quotients cited below are the apparent quotients resulting from the analysis of the products increased by an equal weight of water. They are so given because this method of analysis serves as the base of control in the work of crystallisation; they have been determined separately for each boiling. Numerous analyses were made to establish the relation of the apparent quotients to the real quotients, and above all to the quotients after Clerget, these last being, as is well known, the only ones suited to molasses. Whilst the true ordinary quotients $\left(\frac{\text{Substance fully dry}}{\text{Direct Polarisation}}\right)$ was superior to the apparent quotient by 1·0 for the masse-cuite when cooling and by 2·5 for the molasses obtained by centrifugalling, the quotients according to Clerget $\left(\frac{\text{Substance fully dry}}{\text{Pol. by inversion [Glucose formula]}}\right)$ agreed very nearly with the apparent quotients for the masse-cuite and the mother syrups when cooling and for centrifugalled molasses.

Apparent Quotients of After-Products.

	Masse-cuite when cooling.	Mother syrup when cooling.	C'fugalled molasses.
General mean for campaign	79·65	67·25	59·4
Mean of three last weeks—1	81·3	67·2	60·1
,, ,, 2	79·7	66·8	58·5
,, ,, 3	79·7	66·5	58·3
Isolated boilings—1	80·1	67·0	56·7
,, ,, 2	82·4	67·8	59·4
,, ,, 3	84·0	68·3	60·0
,, ,, 4	81·9	67·5	58·8

Sugar obtained by Centrifugalling the preceding Isolated Boilings.

	Polarisation.	Yield.	Water.
Isolated boilings—2	96·8	—	—
,, ,, 3	97·8	94·55	0·68
,, ,, 4	95·6	88·9	1·44

These figures, which merely show the usual results of the process, are sufficient proof of the efficacity and even the infallibility of this process in so far as it concerns the desugarizing of the molasses runnings.

The quality of the sugar obtained possesses a special interest. The titrages are calculated in the ordinary way, *i.e.*, by deducting the ashes five times from the polarisation. The molasses which surround the crystals in the malaxeurs possess, as we have seen, a strong concentration, and are in consequence very viscous. Under these conditions we obtain in general only very dark sugar having a low titrage. Now in fact the sugars obtained by the Claassen process do not differ at all as regards tint and titrage from the ordinary sugars of first strike; the grain at the most is a little smaller than the average sized grain of a first strike. The purity of the sugar was from the commencement increased by a very simple operation; while filling the centrifugal which was at nearly full speed, one allowed a small jet of hot diluted molasses to fall on the masse-cuite; then as soon as the larger part of the running, the cooling of which has been facilitated, was separated from the crystals, one next poured on it a clairce of about two litres of the same molasses (the charge of the centrifugal was about 90 to 100 kg. of masse-cuite). This small quantity of clairce had the effect of modifying the concentration and the viscosity of the molasses around the crystals, in such a way that the volume and weight represented by it in the raw sugar were relatively feeble compared with those of the mother syrup coming straight from the malaxeurs. In a case where it was desired to take observation of this effect, one found that the molasses adhered to the crystals in the proportion of 12·5 to 8% of raw sugar. The molasses of the centrifugalled crystals possessed nevertheless a slightly superior concentration to that from the runnings of a first strike. The purity of the centrifugalled molasses in it was in no wise influenced thereby, and the obtaining of an after-product of high titrage in these circumstances is due in the writer's opinion, to the quality of the grain at the beginning, and also to the total absence of small crystals in the masse-cuite; these latter cannot occur if one conforms to the directions. The average of a large number of lots of sugar of second strike centrifugalled in this manner by the factory in question, which had an interest in obtaining its sugar as pure as possible, comprised a polarisation of 96·8 and a titre of 92·60; other lots, centrifugalled without clairce, had a mean polarisation of 95·5 and a titre of about 89; the sugar furnished by the solitary boiling No. 4 formed part of them. These sugars were mixed afterwards with the runnings of the first strike and passed directly into the centrifugals.

When minutely controlling the desugarizing in the malaxeurs, and when observing the marked variation in the various factors in the crystallization, variations which one can even bring about purposely if desired, one is soon made aware of a circumstance which has a preponderant influence on the desugarizing of the running, viz., the number and especially the surface of the crystals in the masse-cuite. A masse-cuite of 75 to 77 purity, the crystals of which have a grain

sufficiently large to be directly assimilated, does not crystallize well in the malaxeurs, especially if the coefficient of supersaturation of the running is raised 1·3 to 1·5. On the contrary, another masse-cuite of 82 purity of which the crystals are of the same size as those in the preceding case, and having therefore a more extensive surface, crystallizes well, even with a coefficient of supersaturation in the runnings of 1·35.

A consequence of all this is that it is an advantage from the point of view of facilitating the desugarizing of the running and of the quality of the sugar to be made, to increase the quotient of the masse-cuite; and this matter is of considerable interest to the refineries, who often complain of having too high quotients for the working of their malaxeurs according to the ordinary boiling processes. The isolated examples of masse-cuites cited above show that the raising of the purity of the running has no detrimental effect on the final result, the obtaining of molasses. The yield of sugar, as one sees, is increased in proportion to the purity of the masse-cuites. On the other hand, it would be more advisable, when the quotient is getting too low, towards 72 to 75, to introduce the crystals into the boiling apparatus, an eventuality foreseen and provided for by the Claassen process. As far as the supersaturation is concerned, the writer has generally found that the best results follow with a percentage in water of 9·25 to 9·50 per cent. in the mother syrup when cooling.

It does not appear less evident that the high titre of these second strike sugars can be even partially attributed to the special method of boiling after Claassen. The writer has found several times that the same running, which, boiled to grain after the ordinary method, that is for eight or nine hours under the eye of the attendant, gives in the refining a sugar remaining greyish yellow, whatever might be the quantity of clairce employed, yet when boiled by the Claassen method yields a refined sugar free from reproach. For example some after-products remaining over from the manufacture of a previous year and of very bad quality, on being remelted and boiled by themselves as first strike in an ordinary pan only delivered in the end a sugar of equally bad quality; the running of this masse-cuite treated according to the Claassen method gave a refined sugar of perfect purity and transparency. In a general way, the sugar refined from Claassen masse-cuite is of a superior quality to that produced in refineries from rich runnings of a very high quotient, but boiled to grain after the ordinary method. It seems clear from this that the circulation of the crystals in the boiling pan and the light coefficient of supersaturation of the mother syrup, no doubt owing to their provoking a very regular growth of crystals, exercise a favourable influence on the purity of the crystals themselves.

It is not easy, as we have seen, to reconcile, by the method of boiling to grain, the complete desugarizing of runnings of low quotient

with the obtaining of a sugar which conforms directly to the needs of the refinery, *i.e.*, which represents a superior value; besides, with the feeble quantity of after products which is nowadays in general available for working on in factories making only brown sugar, the advantage of the installation of the Claassen process is in this case doubtful. But it is to be hoped that in the near future this process will be more widely used, and will permit the economical obtaining of all the extractable sugar in one strike and of the best quality; this is what Dr. Claassen is now working for, unless the writer is much mistaken.

As to the factories for white sugar, and to the refineries, they have always an interest in retaining the distinction of at least two products, whilst seeking to effect the greatest economy. For them the Claassen process will doubtless offer, in its present form, considerable advantages.—(CH. GRIERE in the *Journ. des Fabr. de Sucre.*)

THE LIMIT OF ECONOMY IN MACERATION.

By ERNEST E. HARTMANN.

While the opinion, more or less frequently met with until recently, that maceration is a fad, which should be left alone, because "it spoils the juice," has probably but few adherents left, there is a great difference in the views held in regard to the extent to which dilution may be carried to advantage, and there is also a tendency to go to the other extreme. The cause for this variety of opinions lies in the fact that what has been of great benefit in one factory has proved a failure somewhere else. The process may not have been suitable, or prejudice may have proved too strong.

The practice of regulating the maceration according to the amount of bagasse available for fuel has become almost universal in these islands.* The practice is a safe one, and there is, broadly speaking, none of the cane produced here of such low purity that the amount of water used for maceration would have to be limited for fear that the juice extracted would contain so much impurities as to cause an actual loss of sugar.

The question then remains: To what extent is it profitable to supplement the bagasse with coal? The chief factors, which determine this point, are the purity of the juice and the percentage of sugar in the cane. In the first place let us see what purity the juice will have, which we are to extract from the last seven per cent. left in the bagasse. It is evident that this purity will vary with the purity of the cane-juice. Owing to the uneven distribution of the sucrose in the cane, this variation is, however, not constant, and

* Hawaiian Islands.

different varieties of cane in different stages of maturity give widely different results; but averages obtained from a large number of data collected at different factories are sufficiently representative to be of value in calculating the limit to which the sucrose may be profitably extracted by means of water.

In Table I. the purities of the various juices, as they are successively expressed, are given in their relation to the purity of the first mill juice, the latter taken at 95, 90, and 85. The extraction by the individual mills is assumed to be the same in all three cases.

TABLE I.

Extraction % Sucrose in Cane.	Purity of Juice.		Purity of Juice.		Purity of Juice.	
	Ex-pressed.	Left in Bag.	Ex-pressed.	Left in Bag.	Ex-pressed.	Left in Bag.
The first 80	95	85	90	77	85	70
,, following 10	90	79	83	70	76	64
,, ,, 3	88	75	79	68	71	61
,, ,, 1	86	73	77	66	68	60
,, ,, 1	82	71	74	64	65	59
,, ,, 1	77	70	70	63	61	58

By the aid of this table and the formula:

$$\text{Obtainable sugar} = \text{sucrose} - \frac{\text{Brix} - \text{sucrose}}{2}$$

we find the percentage of sugar we would actually obtain for every 1% of sucrose extracted.

TABLE II.

For 1% sucrose extracted between:		10	12	14	16
	PURITY 95. Sucrose % cane	10	12	14	16
93 and 94%	Obtainable sugar % cane..	·092	·110	·128	·147
94 ,, 95%	,, ,, ..	·089	·106	·124	·142
95 ,, 96%	,, ,, ..	·085	·102	·119	·136
	PURITY 90.				
93 ,, 94%	,, ,, ..	·085	·102	·119	·136
94 ,, 95%	,, ,, ..	·082	·099	·115	·132
95 ,, 96%	,, ,, ..	·078	·094	·110	·126
	PURITY 85.				
93 ,, 94%	,, ,, ..	·076	·092	·107	·122
94 ,, 95%	,, ,, .	·073	·087	·102	·117
95 ,, 96%	,, ,, ..	·068	·082	·095	·108

The next thing is to ascertain how much water is required for each additional 1 per cent. of sucrose extracted. I attempted at first to obtain these data from the relation between dilution and extraction, as found in the daily reports of a number of factories. The resulting

average figures were, however, of no value for my purpose, and as there are so many factors besides dilution, which influence the extraction, a satisfactory comparison could hardly be expected. There is the speed and setting of the mill, the temperature of the maceration water, the duration of its contact with the bagasse, the proportion and the structure of the insoluble matter in the cane, the thickness and the regularity of the feed, and the mode and the regularity of the application of the maceration water. All these are factors, which to a greater or lesser extent affect the exhaustion of the bagasse. I had therefore to have resort to calculation for the purpose of establishing the quantity of water which would have to be used for maceration for each 1 per cent. of sucrose extracted above a certain limit. The formula: Diffusion water =

$$\frac{(\text{lbs. Sucr. in Bag. A} \times \text{juice \% Bag. B}) - (\text{Sucr. \% Bag. B} \times \text{lbs. juice in Bag. A}).}{\text{Sucr. \% Bag. B.}}$$

gives us the quantity of water, which would (complete diffusion with the juice in the bagasse assumed) bring the percentage of sucrose in bagasse A to that in bagasse B. A and B represent either Bag. I. and Bag. II., or Bag. II. and Bag. III.

Table III. will show this quantity for 100 lbs. of cane containing 14 per cent. of sucrose and yielding a first mill juice of 90 purity. The percentage of moisture in the bagasse is for the sake of simplicity assumed to be the same throughout.

TABLE III.

Extraction % Sucrose in Cane.	Sucrose in Bagasse % Cane.	Bagasse.			Diffusion Water.	
		lbs.	% Sucrose.	% Fibre.	For total increase.	For the last 1% in extraction.
					lbs.	lbs.
93	·98	236	4·13	50·8	....	....
94	·84	234	3·60	51·3	15·8	15·8
95	·70	232	3·02	51·8	39·5	23·7
96	·56	230	2·44	52·4	74·0	34·5
97	·42	228	1·80	53·2	137·2	63·2

The above quantities of water would in reality not accomplish these results, as the diffusion of the maceration water with the juice in the bagasse is by no means complete. The quotient of diffusion depends upon the percentage of dilution, the temperature of the maceration water, and the condition of the bagasse. The average quotient for simple maceration with, say, 20 per cent. hot water, is about 50; for higher dilution, less.

For the purpose of these calculations I assume this quotient to be 45, 43, 40, and 36 respectively—a low estimate—for single; and with

an increase of say 60 per cent., or 72, 69, 64, and 58 respectively for double maceration.* The quantity of water required would therefore be :—

TABLE IV.

Diffusion Water.	Simple Maceration.		Double Maceration.	
	Quotient of Diffusion.	Water.	Quotient of Diffusion.	Water.
lbs.		lbs.		lbs.
15·8	45	35·1	72	21·9
23·7	43	55·1	69	34·4
34·5	40	86·2	64	53·9
63·2	36	175·6	58	109·0

From Tables II. and IV. follows :—

TABLE V.

Increase in Extraction.	Maceration Water required.		Lbs. Sugar obtained.	@ c.	c.
	Single Maceration.	Double Maceration.			
93 — 94	35·1	21·9	1·19	2·75	3·27
94 — 95	55·1	34·4	1·15	,,	3·15
95 — 96	86·2	53·9	1·10	,,	3·02
96 — 97	175·6	109·0	1·04	,,	2·86

I think this sugar may well be estimated at $2\frac{3}{4}$ c. per lb., as for the purposes of these calculations the cost of manufacture (other than that of the evaporation in multiple effects) may be neglected. The running expenses under ordinary conditions remain about the same, whether 93 or 96 per cent. of the sucrose be taken out of the cane. The extra fuel consumption for pumping (juice pump, circulating pumps), amounting to less than one-fiftieth of that required for evaporation, may also be neglected.

Eight pounds of steam per ton of coal is a conservative estimate. Let us assume that 1 lb. of this be consumed in heating and handling the additional thin juice, an ample allowance. As 1 lb. of steam of 212°F. evaporates in a quadruple effect between three and four times its own weight of water, the remaining 7 lbs. of steam would, taking $3\frac{1}{4}$ as coëfficient, evaporate $7 \times 3\frac{1}{4} = 22\frac{3}{4}$ lbs. water.

* This term is used to designate the practice of utilising the juice from the third mill for the maceration of the bagasse issuing from the first mill.

Table VI.

Comparison between Cost of Coal and Value of Product, 1,000 lbs. Cane.

Increase in Extraction.	Gross Gain.	Simple Maceration.					Double Maceration.				
		Water evap.	Coal required	Cost of coal at ½c.	Net Gain.	Net Loss.	Water evap.	Coal required	Cost of coal at ½c.	Net Gain.	Net Loss.
	c.	lbs.	lbs.		c.	c.	lbs.	lbs.		c.	c.
93 — 94 ..	3·27	35·1	1·54	·77	2·50	..	21·9	·96	·48	2·79	..
94 — 95 ..	3·15	55·1	2·42	1·21	1·94	..	34·4	1·51	·76	2·39	..
95 — 96 ..	3·02	86·2	3·79	1·90	1·12	..	53·9	2·33	1·17	1·85	..
96 — 97 ..	2·86	175·6	7·72	3·86	..	1·00	109·0	4·79	2·40	·46	..

This applies, as will be remembered, to a cane of 14 per cent. sucrose and 90 purity. It shows that with double maceration sufficient water could profitably be evaporated to obtain an extraction of 97 per cent., while with simple maceration 96 per cent. should not be exceeded.

For the purpose of a comparison, I will substitute in the above table the values for a cane containing only 10 per cent. of sucrose and a juice of 85 purity.

Table VIb.

Increase in Extraction.	Gross Gain.	Simple Maceration.					Double Maceration.				
		Water evap.	Coal required	Cost of coal at ½c.	Net Gain.	Net Loss.	Water evap.	Coal required	Cost of coal at ½c.	Net Gain.	Net Loss.
	c.	lbs.	lbs.		c.	c.	lbs.	lbs.		c.	c.
93 — 94 ..	2·09	37·1	1·63	·81	1·28	..	23·2	1·02	·51	1·58	..
94 — 95 ..	2·01	58·6	2·58	1·29	·72	..	36·6	1·61	·81	1·20	..
95 — 96 ..	1·87	95·2	4·19	2·10	..	·33	59·5	2·62	1·31	·56	..
96 — 97 ..	1·65	183·9	8·08	4·04	..	2·39	114·9	5·05	2·53	..	·88

Where Table VI. showed in favour of the use of coal up to 96 and 97 per cent. respectively, in VIb. the limit is lowered to 95 and 96 respectively.

The consumption of fuel is more or less influenced by other factors, such as the deterioration of the value of the bagasse as fuel, owing to the additional exhaustion and a slight increase in the percentage of moisture, also the lowering of the purity of the mixed juices, and a consequent increase in the time required for boiling, factors which would tend to give slightly higher values for the quantity of coal

required; but the estimate for the evaporation per lb. of coal has been made with a view to cover such points, which it would be difficult to express in figures.

The values, as given in this paper, apply to average conditions as they are to be found here in a modern factory, where the cane passes through a crusher or shredder first and then through a nine-roller mill of the design which has proved itself so efficient, and which has been followed in all the mills recently built in Honolulu. The quotients of diffusion have intentionally been chosen low; the amounts of water actually required would in most cases be found to be less than those appearing in the tables. Where it is desired to ascertain the limit for any particular case, this quotient should be determined under average running conditions. It is expressed by:—

$$\frac{\text{Diffusion water} \times 100}{\text{Maceration water.}} = \text{Quotient of diffusion.}$$

The formula for the calculation of the former is given between Tables II. and III. For double maceration it is necessary to determine this quotient separately for the diffusion of the water with the juice in the bagasse from the second mill, and that of the third mill juice with the juice in the bagasse from the first mill. The two added represent the total efficiency of the maceration water.

THE DETERMINATION OF THE WEIGHT OF CANE DELIVERED TO A FACTORY.

By Noël Deerr.

A knowledge of the exact weight of canes worked up in a factory is the fundamental factor upon which all subsequent calculations are based; in all factories it is an essential factor for any system of control; but in central factories where canes are bought, distinguished from self-contained properties, it is doubly important to have a means of checking the weight of canes reported from the balances, as there always arises the possibility of fraud and collusion. The methods for the determination of the weight of canes may be divided into two classes: direct and indirect methods; of direct methods there are two:—

1. *Direct weighing on balances.*—This method leaves nothing to be desired at first sight; the actual operation is, however, usually left to a native clerk, whose accuracy and carefulness may be called in question; there is, moreover, the danger of the balances getting out of adjustment, and, when canes are purchased, the possibility of fraud.

2. *Direct weighing of megass and volumetric estimation of juice.*—In Demerara, where canes are brought to the mill by water, a direct weighing is not feasible, and in some factories there the megass is

systematically weighed; the method adopted is to discharge the megass from the carrier into trucks which run on rails in front of the boiler wall and pass over a weighbridge; two trucks, each holding about 500 lbs. megass, are usually met with; the sum of the weights of megass and juice give the weight of cane. To this method there are the same objections as mentioned above: the reliability of the native operator and the possibility of fraud. In addition there are other sources of error. The megass in its passage from the mills to the boiler wall is liable to lose or absorb moisture dependant on the conditions of the atmosphere; there is also an undetermined mechanical loss of the finer particles of megass, and the system as carried out causes the employment of an excessive amount of manual labour. As regards a check on the reported weights of purchased canes, a combination of the two methods mentioned above should be valuable.

The most commonly used indirect method consists in the determination of the percentage of fibre in cane and in megass. Expressed algebraically, the relation is $\frac{f}{f_1} \times 100 =$ weight of megass per cent. on weight of cane; f being the percentage of fibre in the cane and f_1 being that in the megass. In the conduct of this scheme canes are selected from the carrier and determinations of the fibre made in the laboratory, the fibre in the megass being determined simultaneously. As an example, let $f = 12$ and f_1 40; then $\frac{f}{f_1} \times 100 = 30$, *i.e.*, the weight of megass is 30% of the canes. The juice, therefore, is 70%, and this quantity being determined as usual, the weight of canes can be directly calculated. Although this method is, as an algebraical equation, perfectly correct, it has not in the writer's hands given satisfactory results, for the following reasons:—

It is impossible to obtain a fair sample of canes for analysis, a result not surprising when it is remembered that several thousand tons may enter the factory in a week, and that the analysis can at most be performed on but a few pounds. In addition, besides clean canes entering the mill, a not inappreciable amount of dry straw, leaves, roots, &c., accompany them. Of these, which may amount to as much as 1·5%, no allowance can be made in analysis; but all the same this foreign matter, which is not cane, has been weighed as cane and reported as such in the balance books. For this last reason this method will in general show too low a fibre in the cane, too high an extraction, and too low a weight of cane.

In order to obtain an independent check on the balances, the writer devised the following method, which he believes is original, and free from the sources of error mentioned above. The method is best understood when described as applied to dry double crushing. The determinations necessary are the fibre in first and last mill megass, and the proportion of second mill juice to first mill juice. This ratio

is obtained by determining the degree, Balling, of first mill, second mill, and mixed mill juice. For example: Let the first mill juice be 17·05° Balling, the second mill juice 16·83° Balling, and the mixed juices 17·00° Balling. Then, if the weight of first mill juice be put equal to 1, and that of the second mill juice be x:—

$$1 \times 17{\cdot}05 + 16{\cdot}83\,x = (1 + x)\,17{\cdot}00$$
$$\text{whence } x = {\cdot}294.$$

If B_1, B_2, B_3, are the solids in the first, second, and mixed mill juices, the equation gives, as a general formula,

Second mill juice $= \dfrac{B_1 - B_3}{B_3 - B_2}$, the first mill juice being put equal to unity.

In making this determination it is necessary to obtain the specific gravity of the juices by weighing in a pycnometer; determinations with the ordinary Balling instrument, graduated in tenths of a degree, are not of sufficient accuracy. The ratio of first and second mill juices can also be obtained from analyses of the fibre in first and second mill megass. Let f be the fibre in the cane, f_1 the fibre in the first mill, and f_2 the fibre in the second mill megass. Then, the weight of first mill juice is $1 - \dfrac{f}{f_1}$, the weight of canes being unity. The total weight of juice is $1 - \dfrac{f}{f_2}$, so that the weight of second mill juice is $\left(1 - \dfrac{f}{f_2}\right) - \left(1 - \dfrac{f}{f_1}\right)$. Then, if the first mill juice be put equal to unity, the second mill juice equal to x, we can write
$$\frac{1}{x} = \frac{1 - \dfrac{f}{f_1}}{\left(1 - \dfrac{f}{f_2}\right) - \left(1 - \dfrac{f}{f_1}\right)} = \frac{f_1 f_2 - f f_2}{f f_2 - f f_1}$$

The quantities x, f_1 and f_2 are capable of accurate determination, whence, from the equation above, f is found.

The weight of juice is determined as a part of the factory routine, and is $1 - \dfrac{f}{f_2}$, the weight of the canes being equal to unity.

As a numerical example let $x = {\cdot}294$ as above, $f_1 = {\cdot}30$ (*i.e.*, fibre in first mill megass, 30%), and $f_2 = {\cdot}42$.

Then $\dfrac{1}{{\cdot}294} = \dfrac{{\cdot}30 \times {\cdot}42 - {\cdot}42f}{{\cdot}42f - {\cdot}30f}$, whence $f = {\cdot}1525$, or 15·25%.

The weight of juice per cent. on weight of cane then is $\dfrac{{\cdot}1525}{{\cdot}42} \times 100 = 63{\cdot}39\%$, and the weight of cane is $\dfrac{\text{Weight of juice}}{{\cdot}6339}$.

This scheme is also applicable to maceration processes. The determinations of density of dry crushed juice, diluted juice, and mixed juice

give, as indicated above, data to calculate the ratio of the two. The total amount of juice being known, the exact amount of dry crushed juice can be calculated, and then, if the maceration water be also known, the amount of undiluted juice expressed in the final crushing is also found. From this point the method is as described above. This method introduces a slight error, as the substitution of a more diluted juice in the final megass will affect the percentage of fibre.

In a three-mill plant, provided the juices from the first and second mills are kept in separate gutters and then allowed to mix before meeting the diluted juice, the simple calculation is quite applicable.

The writer has used this method with satisfactory results. Although apparently complicated, it is in reality quite simple, and has the great advantage that the samples taken are almost certain to be representative, the sampling of a uniform layer of megass being a much easier operation than sampling a train load of cane. The determinations of the density of the juices require to be made with great care, as only small differences exist, which form an essential part of the control.

THE WEST INDIA COMMITTEE.

The Annual General Meeting.

The Annual General Meeting of the West India Committee was held at the new Committee Rooms, 15, Seething Lane, E.C., on May 14th last, Sir Nevile Lubbock, K.C.M.G., presiding. The latter made a very interesting speech in dealing with the current topics of the sugar industry. He began by expressing gratitude at the large increase in membership; 91 additional members had been elected in the first four months of this year. He next touched on the Brussels Sugar Convention, and while regretting that our own Sugar Bill had not so far come up for discussion, he considered that before two months were over it would be passed. He thought the Government would like to see more important questions settled before bringing in a controversial bill. He then remarked that there were one or two questions which would have to take up the time of the Committee.

* "As you all know, in consequence of the very low price of rum, we have been endeavouring to find some other means of getting rid of our molasses, and two means have occurred to us. One is by making a concentrated molasses, for which we find there would be a considerable demand from the traders if we can only get over the difficulties of keeping the ash low enough and getting the analysis such as they wish. I think those difficulties can be got over, but there is a third difficulty, which is in regard to the question of duty. If sugar is brought to this country, as long as it does not contain more than 76 per cent. of crystallizable sugar, it only pays a two shilling duty. Now if the sugar contains 76 per cent. of crystallizable sugar

* For the quoted paragraphs we are indebted to the West India Committee's Circular.

it would almost certainly contain 4 per cent., if not more, of glucose, therefore you may say sugar is admitted into this country up to 80 per cent. of both sugars it bears a tax of two shillings. But if that sugar comes in the form of molasses, if both sugars exceed 70 per cent. it then pays two shillings and ninepence. Now one can see no possible reason why molasses should pay ninepence more than sugar which is so much richer. I think that is a point which will have to be represented to the Government, because I think that ninepence might be quite sufficient to put an end to the trade which I think promises, and promises fairly, to be a trade of some importance."

The other question was on cattle foods; these whether under the name of "molascuit" or otherwise had molasses as their chief ingredient, and while they fetched £4 or £5 in the market, they had to pay a duty of £1; this was a very heavy tax, but as the total quantity of such foods likely to be imported would not be very great, it would be a very small matter for the Government to remove the tax altogether. If unhampered by a duty, this cattle food might be sold to a considerable extent in this country.

Dealing with the work of the Imperial Department of Agriculture in the West Indies, Sir Nevile said:—

* "I think we all agree that Dr. Morris and those under him are doing most excellent work in the West Indies as regards the seedling canes. Though perhaps we have not quite arrived at what we expected to, when these seedling experiments were first undertaken, but we have undoubtedly arrived at something which is of very considerable advantage to us. It seems to be beyond doubt now, that we can grow very fine crops of seedling canes. I do not know whether Mr. Duncan, who I am glad to see present, can confirm that. That is the result of our experience, and I think it is also clear that there is more vitality about a seedling cane than about a Bourbon, and where the seasons are not very favourable the seedling cane will stand it better than the Bourbon cane. Those are two very great advantages attaching to the seedling, which I may say were not possibly anticipated at the time the seedling experiments were started, but we may be well satisfied that we have gained considerably in those two ways. But the Imperial Department of Agriculture has not been satisfied with merely making experiments with seedling canes. They have been dealing with a great number of other things. I notice from the latest publications, that they are now making experiments in the growth of cotton; that they are almost beyond the experimental stage in regard to the growth of onions, which is becoming an appreciable crop in some of the islands; that honey has received their attention; and, as you all know, cattle diseases, the diseases of poultry, the diseases of cocoa, the diseases of sugar cane, and the diseases of all the crops generally have been receiving most careful attention. It is therefore quite clear that the Department is doing most excellent

work in the West Indies, and I think, as I have said once before, that perhaps the work that will be of most use and importance to the West Indies is the work of education which is practically being carried on by them. I do not mean alone the education that they are providing at the schools, but the education of the people by calling their attention to all these different diseases of their crops and the proper manner to grow them. I feel sure therefore, that it would be quite your wish that we should heartily thank Dr. Morris and those under him for what they are doing in the West Indies. (Hear, hear!) Already we see signs of good results."

The remaining topics touched on included the West Indian fruit industry, the turtle industry, the erection of central factories, and the effects of the Brussels Convention on accumulated stocks after next September. There seemed some doubt whether the abolition of bounties would have any impression for another six months owing to the large quantities of bountied stocks held over in Germany and Austria.

SUGAR MACHINERY FOR JAPAN.

The following, taken from the *June* BRITISH TRADE JOURNAL, will doubtless be of interest to same of our advertisers:—

The Tokyo manager of THE BRITISH TRADE JOURNAL, *Japanese Edition*, writes as follows: It has been decided by the Governor-General's Office of Formosa to purchase from Great Britain a sugar machinery plant, for which a sum of 100,000 yen has been voted. I have been invited to furnish them with the c.i.f. prices and particulars, according to their rough specification prepared in Japanese, which I translate as follows for the benefit of your readers:—

One sugar cane crushing mill, the diameter of rolls to be 16 in., the length 20 in., provided with a double gearing and iron base-plate.

One conveyor. The length of the conveyor for conveying sugar cane stalk to be 50 ft., and that for conveying sugar cane chaff to be 30 ft.

One steam engine of 24 H.P. The diameter of cylinder to be 9 in., stroke, 14 in.; diameter of the hand wheel, 4 ft.; and the width to be 12 in.

One boiler of 84 H.P. The diameter to be 60 in., the length of the tubes (82 pieces in number) to be 16 ft., and the diameter, 3 in. The heating surface to be 1,172 square feet.

One boiler feed pump. The steam cylinder, 5 in.; water cylinder, 3 in.; stroke cylinder, 6 in.; steam pipes, $\frac{1}{2}$ in.; exhaust pipes, $\frac{3}{4}$ in.; suction pipe, $1\frac{1}{2}$ in.; and delivery pipe, $1\frac{1}{2}$ in.

One pump for syrup. Cylinder diameter, $3\frac{1}{2}$ in.; stroke, 5 in.; diameter suction pipe, $1\frac{1}{2}$ in. (capacity, 500 gallons).

Three clarifiers with copper pipe arrangement and the capacity 700 gallons.

Two evaporating pans, provided with copper made double hose and the capacity to be 450 gallons.

One finishing pan made with copper and the capacity to be 650 gallons.

One centrifugal machine. The diameter of baskets to be 30 in., capable of separating 9,000 lbs. of sugar per day of twelve hours at a given power of 5 to 6 H.P.

One complete set of accessories, consisting of pipe connections for the steam engine and boiler, injectors, iron pipes, pulleys, cocks, belting, shafting, hangers, &c.

AUSTRALIA.

The Sugar Production 1901-1902.

The annual report of the Australian Sugar Industry is admirably summarized in *The Year Book of Australia*, in an article of three pages. Having been favoured with an advance copy of that portion of the work, we are enabled to reproduce below such parts of it as will be of general interest to our readers.

The position of the Australian sugar-growing industry during 1901-2 was one of considerable uncertainty, by reason of the impossibility of forecasting the probable results of Federal legislation with respect to the employment of coloured labour. Under the provisions of the Pacific Island Labourers' Act, as the measure is designated, a limited number of kanakas are allowed to enter Australia until March 31st, 1904, after which their admittance will be refused. All agreements for the employment of kanaka labour will terminate on December 31st, 1906, after which any Polynesians found in the Commonwealth will be deported to their respective islands; and in 1907 sugar cultivation will have to be carried on by white labour alone. With a view to encouraging the employment of white labour, the Federal import and excise duties have been fixed as below:—

Federal duties on imported sugar	.. .. ..	£6 per ton.
,, Excise on sugar—		
Grown with black labour	....	£3 ,,
,, ,, white labour ..	..	£1 ,,

In other words, sugar grown with white labour is allowed a rebate of £2 per ton. The amount of rebate paid during the year ending 31st December, 1902, was £23,955, among 1,525 claimants. This represents about one-seventh of the Queensland sugar crop, coloured labour not being required in New South Wales, where the conditions are more favourable to white labourers. If the rebates were allowed on all the sugar grown they would form a total of £240,000 for Queensland alone, and one of the questions which has arisen in connection with the subject is—Which are to bear the loss of excise revenue occasioned by the rebates—Queensland and New South Wales, the two sugar-producing States, or the Commonwealth?

The course proposed by the New South Wales Premier is as follows:—"The total revenue derived from the duty and excise on sugar having been ascertained, there should be deducted therefrom the so-called rebates allowed on white-grown sugar, and the balance distributed among the various States in proportion to the quantity of

sugar consumed by them. By adopting this plan the carrying out of the policy of the Commonwealth in regard to coloured labour would be made a charge on the people of the Commonwealth as a whole, while the anomaly of adjusting duties received by a State according to the method of distribution adopted by the parties concerned in the distribution would be done away with, and each State would receive a return from the Commonwealth based on its consumption of sugar, whether such sugar is grown in the State or imported thereinto."

The whole of the difficulty has arisen out of what is popularly known as the "Braddon clause" in the Federal Constitution, whereby the accounts of each State have to be kept separate until the termination of a certain specified period, so that the Federal customs and excise revenue may, after defraying the cost of Federal administration, be returned to the States in proportion to the amount contributed by each. Consequently if the rebates on white sugar in Queensland and New South Wales are defrayed from the excise duties levied in those States, the amount of excise duty contributed by them to the Federal treasury would become proportionately decreased, also their share of the Federal surplus revenue. The two States would, in fact, be bearing the whole cost of preparing the way for a "white Australia," instead of its being borne by the Commonwealth.

Mr. Philp, the Queensland Premier, suggests, as a solution of the difficulty, that payments to the white growers of sugar should take the form of a bonus, payable out of the Federal revenue, which would throw the cost on the whole of the States, instead of on two, as at present; but the Australian Prime Minister has pointed out that this cannot be done, the Federal Parliament having sanctioned the payments only in the form of rebates, and not as bonuses. The Federal Government is virtually powerless in the matter.

It is perfectly clear that the attempt to differentiate between the produce of white and coloured labour is surrounded by unexpected difficulties, which do not seem capable of immediate solution, save on the lines indicated by Sir John See. The rebates, as anticipated, have been enjoyed principally by sugar-growers in the southern districts of Queensland, where the conditions of cultivation approximate to those of the New South Wales sugar-growing country, the northern districts so far, being unable to substitute, at any rate, not to any perceptible extent, the services of the white labourer for those of the kanaka, a fact which threatens serious trouble in the near future.

The Federal import duty of £6 per ton is considered sufficient to restrict the admission of bounty-fed beet sugar from Europe, unless it be produced at a cost lower than any yet recorded, a most improbable contingency.

New South Wales.

There is some doubt whether the sugar-growing industry in New South Wales will not become supplanted to a considerable extent by dairy-farming and other enterprises of a more remunerative nature, the cane in the mother State being liable at times to injury from frost, which tends to impair the quantity and quality of the produce. The work of cultivation is confined principally to the extensive and luxuriant districts watered by the Richmond, Tweed, and Clarence rivers, the soil and climate of which are admirably adapted for the purpose. Formerly the industry extended in a southerly direction as far as the Macleay River, but the frequent losses occasioned by frost led to its being abandoned. The dairying resources of the district are, however, so great that it is not improbable the near future will witness the butter and cheese factory largely taking the place of the sugar mill.

Queensland.

The condition of the Queensland sugar industry in 1901-2 displayed a marked improvement on that of the previous year, the output, 120,858 tons, showing an increase of 28,304 tons on that of 1900-1. The total area under sugar in 1901-2 was 112,031 acres, being the largest yet recorded in the State. On this the produce of 78,160 acres was crushed. In 1898-9 and 1899-1900 the area was larger, but the increase in 1901-2, following the decline in the previous year, shows that the industry is surmounting the obstacles which threatened its prosperity.

In addition to the 52 manufactories, there are two refineries and six crushing mills. In 1902-3 the effects of the drought became apparent in the production being diminished to a lower extent than at any time during the preceding eight years, the output being estimated by a leading authority at about 83,750 tons. Very little white labour, we are told, was employed cutting in the north, but, with the exception of the Burdekin district, the season was, on the whole, a profitable one, although in the Mackay district it was possible only by reason of the rebate paid by the Federal Government to those employing white labour in cane cutting. In many cases the growers, with the assistance of their wives and children, not only kept in their pockets the money formerly paid for coloured labour, but also obtained from the Federal Government the rebate allowed on white-grown sugar. The employment of white women and children in semi-tropical field work may be open to question, but it is one of the inevitable results of the abolition of coloured labour. The sugar production of the three divisions of the State, also that of molasses, is shown in the following table:—

QUEENSLAND SUGAR AND MOLASSES PRODUCTION, 1901-2.

	Sugar tons.	Molasses gals.
Southern Districts :—		
Bundaberg and Gin Gin, Childers, Maryborough, and Tiaro	36,205	1,251,402
Logan	1,159	43,500
Marburg and Rosewood	343	25,000
Maroochy and Gympie	831	35,000
Nerang	629	30,000
Central District :—		
Rockhampton	690	14,500
Northern Districts :—		
Ayr	10,724	—
Bowen	1,610	—
Cairns and Douglas	18,882	694,060
Ingham and Mourilyan	25,692	839,700
Mackay	24,093	746,790
Total	120,858	3,679,952

The losses occasioned at times by protracted droughts have naturally caused increased attention to be given to the question of irrigation, the necessity for which in districts of low average rainfall is unreservedly admitted. Where the system has been introduced, as in the Ayr district, the results have been remarkable, an area reduced by 126 acres, giving an increased output of 3,277 tons. Where the crop was affected by drought the stunted cane was used as fodder, proving a boon to stockholders in places where food was scarce, showing that sugar cane, even in poorly developed condition, may be looked upon as an exceptionally valuable emergency crop in periods of drought or fodder famine. The importance of the sugar crop as an article of export is shown by the following figures :—

QUEENSLAND PRODUCE TRADE, 1901-2.

	Imports. £	Exports. £
Grain, fruit, vegetables, &c.	912,141	174,340
Dairy produce	3,903	92,186
Sugar	721	792,329

The total value of the 1901-2 crop was estimated at £501,600, or £4 9s. 6d. per acre; and that of New South Wales at £83,400, or £4 0s. 2d. per acre. It should be mentioned that while in Queensland a crop is obtained yearly from the greater portion of the sugar growing area, in New South Wales the cane is cut only every second year, which explains the seeming unproductiveness of the crop in the latter State.

IMPORT AND EXPORT TRADE.

Athough the Federal import duty of £6 per ton has naturally had the effect of raising the price to consumers, it has not materially

effected the volume of imports, the local production being totally inadequate to meet local requirements. Thus, while in 1901-2 the Australian production of sugar amounted to 6,453,880 cwt., the oversea imports fell very far short of that quantity. The quantities and values of the inter-State and oversea imports during the last two years are subjoined:—

AUSTRALIAN SUGAR IMPORTS, 1900-2.

	1900-1. Cwts.	1901-2. Cwts.
New South Wales	1,192,659	1,084,132
Queensland	528	2,750
South Australia	602,832	598,313
Tasmania	199,738	197,473
Victoria	1,106,825	1,371,039
Western Australia	174,540	181,913
Total	3,277,129	3,435,620

VALUES OF AUSTRALIAN SUGAR IMPORTS, 1900-2.

	1900-1. £	1901-2. £
New South Wales	738,548	754,390
Queensland	550	630
South Australia	377,271	363,668
Tasmania	114,498	144,262
Victoria	675,865	855,424
Western Australia ...	128,889	132,539
Total	2,033,621	2,250,913

The New South Wales oversea imports were principally from Mauritius, Germany (beet), Fiji, and Hong Kong; those of South Australia from Mauritius; and those of Victoria from Mauritius, Hong Kong, and Java; Queensland, Tasmania, and Western Australia obtained their outside supplies (Australian and oversea) from the other States. The exports were largely of an inter-State character, New Zealand being the leading purchaser outside the Commonwealth. The Federal duty of £6 per ton has checked the Fijian exports to Australia, the trade becoming diverted to New Zealand and Polynesia, but the quantity is not sufficiently large to have an appreciable effect on the Commonwealth export business. The Australian exports during the last three years were as follow:—

AUSTRALIAN SUGAR EXPORTS, 1899-1902.

	1899-1900. Cwt.	1900-1. Cwt.	1901-2. Cwt.
New South Wales.. ..	400,614	224,555	262,107
Queensland	2,181,711	1,256,155	1,321,017
South Australia	84,025	168,406	186,801
Tasmania	15	10	7
Victoria	157,924	116,170	190,384
Western Australia	....	691	183
Total	2,824,289	1,766,687	1,960,499

. VALUES OF AUSTRALIAN SUGAR EXORTS, 1899-1902.

	1899-1900. £		1900-1. £		1901-2. £
New South Wales.. ..	240,897	....	156,878	....	185,672
Queensland	1,163,010	....	669,389	....	789,191
South Australia	63,920	....	123,893	....	134,477
Tasmania	18	....	10	....	5
Victoria	144,867	....	109,737	....	158,345
Western Australia ...	727	...	541	....	162
Total	1,613,439	....	1,060,448	....	1,267,852

These figures illustrate, so far, the effect of Federation upon the Australian sugar trade, showing that when the local supply is plentiful there is a tendency to utilise it for home consumption in preference to the foreign article, a predeliction largely based on the admittedly superior character of the Australian product.

BEET SUGAR.

Although Australia is capable of becoming one of the great sugar beet growing countries of the world, its cultivation is yet a thing of the future, even in Victoria, where, despite State assistance of the most liberal character, the production was only 42,560 cwt. in 1901-2. In New South Wales, beet of the finest quality has been experimentally grown, but beyond that stage there has been no advance. The latest published statistics do not give any details of the imports of beet sugar, but they amounted to 57,420 cwt. in 1899-1900, and 11,800 cwt. in 1900-1. It is probable that the figures were higher in 1901-2. New South Wales in that year importing 87,931 cwt. of sugar from Germany, the bulk of which, if not the whole, being from beet.

If it were possible to substitute beet for cane, the question of white labour would speedily become settled, but there are grave difficulties in the way, as the change would render useless the costly crushing and refining plant now in operation. The European cultivation of beet, especially in Germany and Austria has been stimulated by heavy bonuses by the various Governments, to such an extent that the production shows a surplus greater than the quantity required for local consumption. The latest statistics show that the annual aggregate European production was 5,970,000 metric tons, of which 2,845,000 tons were required for home consumption, leaving a surplus of 3,125,000 tons, of which Great Britain took nearly 1,700,000 tons. These figures will show the magnitude attained by the industry in Europe alone.

The Mexican sugar canes last from three to eight years, according to the district and climatic conditions. In fact so favourable are the conditions to the growth of canes, that, according to an expert, if as much care was bestowed on them as is done in Louisiana, the Mexican planter's profits would be fabulous.

UNITED STATES.

New Orleans and District.—The sugar crop of the past season, although larger than its predecessor, was nevertheless a disappointment, not only because the total yield fell short of early expectation, but also because prices were low and unprofitable. The sugar section of the State of Louisiana has felt the ill effects of a succession of poor crops. The yield was about 300,000 tons, as compared with about 275,000 tons the previous year.

An encouraging feature of the sugar trade is the successful use made of bagasse (the crushed stalk of the sugar cane) by converting it into paper, and thus saving what hitherto was thrown away as waste. The paper manufactured from bagasse has proved to be of the highest grade of wrapping paper.

The output of the sugar refining industry of New Orleans is placed at £4,536,984 for the past season The sugar refineries have a daily capacity of 8,000 barrels.

Next to New York and Philadelphia this city is the most important sugar refining city in the United States. The bulk of the sugar imported for refining has come from Cuba, but some little beet sugar has been brought from Germany.

In different kinds of sugar machinery the city competes with Philadelphia, New York, and Cincinnatti, supplying Cuba, Mexico, and even Hawaii. The use of Beaumont oil as fuel has caused a demand for burners and furnaces, &c., which the local foundries are now supplying.

Baltimore.—Sugar to the value of £47,858 was imported into Baltimore during 1902. It came principally from Austria-Hungary, Germany, and Canada.

MEXICO.

The cultivation of sugar cane has greatly increased all over the country. Improved machinery is being used for the manufacture of sugar everywhere. Mexico has a high duty on imported sugar, and can now produce enough for home consumption. As there is no foreign competition, the sugar planters are making their fortunes.

The country has to-day 1,124 sugar mills, of which 116 produce about 100 tons of sugar; 16 produce from 50 to 100 tons; 992 produce less than 50 tons; besides, there are various new mills under construction in different parts of the country which, within two years, will each produce 100 tons at least. It is estimated that the sugar crop, which will commence this November and terminate about February or March, will be fully 100,000 tons.

CHILI.

Coquimbo.—454 tons of sugar, valued at £10,225, were imported into Coquimbo during 1901.

Samoa.

Sugar cane grows well here. When the Director of the Mauritius Botanical Gardens visited Apia in 1880, he informed the manager of the Godeffroy Vallele cocoanut plantation, four miles from Apia, that the sugar cane growing there was the finest he had seen in the islands. No objection, excepting the want of water carriage, can be urged against sugar production in Samoa.

France.

Havre and District.—The amount of sugar imported into Havre during 1902 came to 17,092 tons, as compared with 20,775 tons in 1901. It nearly all came from the French West Indies.

The exports were as follows:—

Port.	Quantity. 1901. Tons.	1902. Tons.
Caen	4,491	770
Havre	12,713	9,091
Honfleur	3,000	1,765
Rouen	58,876	6,501
Tréport	51,140	24,743

Most of it was in transit to the United Kingdom.

Nantes.—Some 47,320 tons of sugar were imported into Nantes during 1902 from the French West Indies, as compared with 46,315 tons in 1901.

The exports of sugar were as follows:—

	1901. Tons.	1902. Tons.
From Nantes	22,449	15,605
,, St. Nazaire	7,420	6,239

It was destined for the United Kingdom and Belgium.

Greece.

Consulate District of Piræus.—Imports of sugar:—

From	Quantity. Tons. 1901.	1902.	Value. £ 1901.	1902.
Austria-Hungary	4,219	4,071	36,600	35,316
Other countries	45	41	390	350

Roumania.

The total amount of sugar produced during 1901-02 was 25,868 metric tons, an increase of 7,117 metric tons on the amount for 1900-01. The above is accounted for as follows:—

Manufactory.	Balance on April 1, 1901. Metric tons.	Production, 1901-02. Metric tons.	Taken over from other Manufactories. Metric tons.	Total Metric tons.
Roman	2,447	10,243	40	12,730
Maraseshti	3,170	4,184	—	7,354
Chitila	2,030	3,048	—	5,078
Branceni	373	3,007	—	3,380
Ripiceni	53	3,497	—	3,550
Sascut	617	1,889	250	2,756
Total	8,690	25,868	290	34,848

Of the above totals, 16,388 metric tons were consumed in the country, and 4,456 metric tons were exported. By taking waste into consideration, transport to other manufactories, &c., an amount of 21,499 metric tons is arrived at, which represents the quantity leaving the manufactories 1901-02. This would mean a balance left over on April 1st, 1902, of 13,349 metric tons.

The taxes levied on the production showed receipts giving £19,665.

Up to 1902 sugar was mostly exported in a refined state to Turkey. In 1902, however, the export was given up in consequence of the Roumanian Government having imposed a tax of 15 centimes per kilo. on all exported sugar.

As sugar was sold in Constantinople at 3½d. the kilo. (1⅗d. per lb.) it became impossible to compete any longer.

CHINA.

Canton.—Imports of sugar from foreign countries.

	Average last five years. Cwts.	1901. Cwts.	1902. Cwts.
Brown	4,524	10,984	8,378
White	56,000	59,186	139,871
Refined	26,600	71,069	56,711
Candy	3,200	9,394	2,702

The large increase in white sugar is due to the abnormal influx of beet sugar from Europe.

In 1902, 148,214 cwts. of brown sugar were exported as compared with 173,727 tons in 1901.

Hankow.—The low prices of Hong-Kong refined sugars, caused by the competition of Continental beet sugars with them, led to an increased demand, and perhaps it was for this reason that native crude sugars from Swatow and Canton were not so much sought for. Hupei province is authorised to levy a special 10 per cent. tax on sugar, as well as on native spirits and tobacco therein consumed; but the tax office tries to collect the impost on all sugar passing through Hankow, and, as there seems to be difficulties in the way of taking out transit passes, Hankow found itself unable to compete with Chinkiang in the supply of the large market in the adjoining province of Honan, and the year closed with a large stock in godown. It is hoped that a warning that foreign sugar protected by transit pass will not be subject to this provincial tax, and that, if pressed, dealers will resort to passes, may lead to a substantial reduction of this damaging levy.

Chinkiang.—The British Consul states the most important item in the customs returns is sugar, foreign and native, the following trade being shown:—

	Quantity.		
	1902. Cwts.	1901. Cwts.	Average previous five years. Cwts.
Sugar, foreign	897,478	520,607	431,748
,, native	222,918	275,410	318,745

It should be explained that a large part of the so-called foreign sugar is really native sugar, grown round Swatow, and shipped thence to Hong-Kong, from which colony it comes direct to Chinkiang, and is thus able (as coming from foreign parts) to go up country under transit pass and escape to a certain extent likin exactions on the way. The very large increase in foreign sugar in 1902 is doubtless due in some measure to the extortions of the likin harpies, whose rapacity has been stimulated by the rumours of an obnoxious foreign treaty calculated to put an end to their exactions.

Correspondence.

To the Editor of "The International Sugar Journal."

Dear Sir,—I have noticed the remarks in your interesting Magazine in reference to British and American cane mills. I have been living amongst sugar machinery for the last fifty years, and am well acquainted with both varieties of cane mills. Up to within the last ten years no cane mills could beat those made in Britain, and, although the British manufacturers have not gone backwards, they have not made such progress as those in the United States, who have in less than ten years jumped up from a very poor mill indeed to what to-day is the very best mill made anywhere. This, however, can be claimed only by two or three manufacturers in the States. Most of the others build their mills pretty much on British lines.

The responsible parties who ordered a nine-roll mill for the Plantation Diamond from the States were quite correct in the statement that such a mill cannot be had to-day in Britain. I would be pleased to have some of my sugar mill making friends from Britain for one day on one of the factories here, where they could see two sets of mills working side by side. One is on the British plan, and quite equal to the best British practise, *i.e.*, three three-roll mills with three gearings and three engines with their long intermediate bagasse carriers and other complications. The other is a nine-roll mill with one gearing and one engine. This engine has one cylinder 30 in. × 60 in., making 45 revolutions. All the rolls of both mills are 78 in. × 34 in., and the steam pressure is 80 lbs. The nine-roll mill takes about one-half of the house and foundations that the three three-roll mill does. The former works with one-third less steam and two-thirds less attendance that the latter requires. The amount of work done on each mill is about the same, *i.e.*, 45 short tons per hour; but the quality of the work is much better done by the one-engine mill. This is not the result of better quality of work or details; in fact, the best made machinery is that of the three-engine set. The better results from the one-engine mill is the result of the steady working of the one-engine mill in relation to speed of each

set of three rolls, *i.e.*, the speed of all nine rolls is always in proper relation to each other; no variation of the proportionate speed can take place with the one-engine mill, no matter how much the feed may vary. In the three-engine mill the speed between each unit is constantly varying with the feed of cane.

The mill I refer to is not the best, that on the Diamond and others like it, are better. The addition of a crusher to such a mill will increase the output 20 per cent. without any additional power or attendance, giving the same extraction, and lowering risk of breakage and repairs. I hope the facts on this subject published in your Journal will tend to "wake up John Bull" both north and south of the Solway. If not he will certainly be left behind in the sugar-mill race.

Yours truly,

ROBERT GRAHAM.

Ponce, Porto Rico, May 23rd, 1903.

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. THOMPSON, C.E., F.C.S., M.I.M.E., Chartered Patent Agent, 6, Lord Street, Liverpool; and 322, High Holborn, London.

ENGLISH.—APPLICATION.

11136. O. IMRAY, London. (Communicated by Fabriques de Produites Chimiques de Thann and de Mulhouse, Germany.) *Improvements in the manufacture of saccharine.* 15th May, 1903.

ABRIDGMENTS.

17502. W. P. THOMPSON, Liverpool. (A communication by the Vereinigte Kunstseidefabriken A. G., Germany.) *Improvements in the manufacture of alkaline solutions of viscose.* 8th August, 1902. This invention consists in the manufacture of an alkaline gelatinous solution of viscose by dissolving it in a solution of caustic soda and potash, and subsequently heating this solution to 40° C., or to a higher temperature, with the object of imparting to it greater permanency (keeping properties), and obtaining a colourless separation of the cellulose hydrates by means of suitable precipitants.

4858. C. SUDRE, Paris, France. *Process of treatment of the residuary liquors of sugar factories.* 2nd March, 1903. This invention consists in a process for extracting from vinasses the glycerine therein contained, in the form of a mixture of glycerine and water, to be concentrated, and for producing a residue containing all the nitrogen consisting in, after having previously rendered the vinasses acid, making it flow on to the walls of an enclosure where there is a vacuum, the walls being heated to a maximum temperature of 300°, the vinasses enters and flows away in a liquid state, without the intervention of mechanical agents, after having in its passage, of

which the length is calculated according to the nature and thickness of the flowing liquid film, lost under the action of the vacuum and heat combined, first of all its water, then its glycerine, the steam produced in the apparatus itself being submitted to a gyratory movement to rid it of particles carried with it and being super-heated at the same time it envelopes the anhydrous material and aids the escape of the glycerine still to be freed.

5439. C. STEFFEN, Vienna. *Improved process of and apparatus for obtaining pure concentrated beetroot expressed juices and expressed residues rich in sugar.* 9th March, 1903. This improved pressing process of obtaining pure concentrated beetroot pressed juices and saccharine pressed residues poor in water as nutritious foodstuff, is characterized by the fact that fresh beetroot chips, beetroot slices, or similarly disintegrated fresh beetroots, which have been previously heated to temperatures of 60° Celsius to 97° Celsius (preferably 80° Celsius) by means of sufficient quantities of pressed raw juice heated to temperatures of 60° Celsius to boiling point, are subjected after the entire or partial separation of the pressed raw juice employed for heating, or together with this juice, to a juice extraction by pressing the beetroots in known presses, whereupon the obtained pressed raw juice is heated as stated and caused to act upon new quantities of fresh disintegrated beetroots (chips and the like) in the same manner and for the same purpose before being manufactured into sugar.

* 8011. J. McNEIL, Govan, Lanark, N.B. *Improvements in sugar cane mills.* 7th April, 1903. This invention consists in providing in sugar cane mills a dumb returner, having its under-side formed with a flange or strip at its back edge to engage in a counterpart check or recess in the top side of a bar supporting it, the bar having wedge-shaped ends held in openings in the housings by means of wedge bolts.

GERMAN.—ABRIDGMENTS.

137812. Dr. HERMANN CLAASSEN, of Dormagen. *An apparatus for regulating and controlling boiling down.* 16th April, 1902. (Patent of addition to Patent No. 117531, of the 12th February, 1899.) The apparatus for regulating and controlling described in the principal patent is modified by the apparatus being provided with a vacuum scale and a boiling point table, in order to allow of the boiling point temperatures necessary for the boiling down to be ascertained; the said scale and table being placed in such relation to one another that the indicator adjusted to correspond to the actual vacuum on the vacuum scale simultaneously indicates on the table the boiling point temperature necessary for each stage of the boiling down.

138693. Dr. M. KOWALSKI and ST. KOZAKOWSKI, Warsaw. *A method for testing the separation and saturation of sugar juices by means of tannic acid or gallic acid.* 20th October, 1901. In order to

determine the quantity of lime necessary for the preliminary precipitation and the final precipitation, and also the alkalinities most favourable for the saturation juice, test reactions are made by means of tannic acid or gallic acid, the juice being treated cold with rather more lime water than suffices for precipitating the non-saccharine substances, and then the excess of lime is counteracted by means of tannic acid (tannin) or gallic acid until alkalinity disappears.

139548. Franz Hampf, of Elbe-Teinitz, Bohemia. *A periodically working centrifugal, the downwardly enlarged drum of which is connected in the centre with the spindle.* December 7th, 1901. The centrifugal is provided with a downwardly enlarged centrifugal drum, adapted to be closed by means of a bottom vertically displaceable on the spindle of the centrifugal. The discharge of the drum is operated whilst it is running by the drum bottom being moved downwards by means of a rod. When the discharge has been completed, the bottom of the drum is again moved upwards, and the drum thus closed beneath. A r[illegible] located in the drum shares in the movement of the drum bottom in order to complete the discharge of the centrifugalled material.

139827. H. Putsch & Co., of Haagen, Westphalia. *Double knife-box for shredding machines.* 1[illegible]th December, 1900. (Patent of addition to Patent No. 129029, of the 8th June, 1900.) In patent No. 129029, devices for supporting the beetroots are provided at the front knife in front of the cutting edge of the rear knife. In this patent of addition these support surfaces are no longer arranged on the front knife, but on the covering bars or ribs formed on the knife holding bar of the front knife.

140118. Georg Apel, of Grünau, Moravia. *A centrifugal drum operated from below by a vertical shaft, and provided with bottom discharge.* 18th June, 1901. The drum is directly provided on the bottom or on the chine, with an annular bearing in such a way that the bell or hood-shaped pan bottom is carried through the bearing.

140333. Herman de Vries Robbe, of Amsterdam. *Centrifugal for any kind of material requiring to be centrifugalled, more particularly, however, for casing sugar with steam or gas.* May 7th, 1902. Wing-like projections are attached to the upper and under side of the centrifugal drum. By means of these wings or arms a flow is imparted to the steam employed for casing sugar emerging from the centrifugal drum which prevents said steam passing into the space above and below the drum, and conveys it to a specially-arranged discharge pipe.

140415. Strontiania, G.m.b.H., of Berlin. *A method of treating bistrontia saccharate in the suction apparatus.* 30th August, 1902. The suction cloths are covered before or during the feed with open wire straining boxes, which catch the deposit of bistrontia saccharate, and after the solid pressed cake has been formed, may be easily

removed, together with the latter from the filter cloths, whilst hitherto the filtered cake had to be divided by means of scoops and scooped out.

141065. HEINRICH PASSBURG, of Moscow. *Process for treating refinery masse-cuite.* 13th July, 1901. The masse-cuite is artificially cooled to about 0° immediately after its removal from the vacuum boiling-down apparatus in the form of loaf, slab or lump sugar. By this means a greater yield of sugar and a much clearer green syrup is obtained than in the ordinary slow cooling at ordinary temperature.

140601. Dr. HEINRICH WINTER, of Charlottenberg. *Apparatus for closely separating drain of different constitution within the centrifugal.* 15th June, 1902. (Patent of addition to Patent 137297 of February 15th, 1902.) In the object of the main patent the catch casing operating the separation of the drain, and inserted between the centrifugal drum and the casing of the centrifugal, consists of separate vertical plates, pivotally arranged on the dividing ridge of the catch gutter. By the present invention these plates are pivotally mounted on or in proximity to the centrifugal casing, so that the separating device may be employed also in centrifugals in which the interstice between the drum and the casing is small. The plates are also provided with drain gutters at their lower ends.

The production of centrifugal sugar and molasses in Mexico during 1902 is given as follows:—

	Tons.
Sugar	96,527
Molasses	72,436

The West India Committee and the Anti-Bounty League have removed from Billiter Square Buildings to more commodious and convenient premises at 15, Seething Lane, London, E.C. As this step was rendered necessary owing to the considerable increase in membership and growing importance of their work, they are to be congratulated.

IMPORTS AND EXPORTS OF SUGAR (UNITED KINGDOM)

To end of May, 1902 and 1903.

IMPORTS.

Raw Sugars.	Quantities.		Values.	
	1902.	1903.	1902.	1903.
	Cwts.	Cwts.	£	£
Germany	3,396,115	1,562,703	1,197,178	623,780
Holland	191,342	118,455	62,509	44,721
Belgium	342,919	539,647	126,372	225,212
France	1,410,696	272,250	556,185	124,013
Austria-Hungary	52,515	1,147,185	18,036	482,741
Java	....	....	....	....
Philippine Islands	....	70,646	....	25,285
Peru	65,138	111,836	22,114	42,758
Brazil	355,301	51,584	118,002	20,249
Argentine Republic	502,711	78,345	187,398	34,949
Mauritius	185,562	162,036	67,831	57,092
British East Indies	48,271	67,203	20,275	25,448
Br. W. Indies, Guiana, &c.	782,308	358,779	467,670	225,209
Other Countries	82,736	289,645	33,831	129,987
Total Raw Sugars	7,415,614	4,830,314	2,877,401	2,061,444
Refined Sugars.				
Germany	6,867,983	5,664,641	3,652,595	2,933,423
Holland	1,165,530	835,976	680,786	483,949
Belgium	92,612	71,172	54,850	42,193
France	1,802,905	365,070	928,987	209,635
Other Countries	10,817	400,660	5,189	197,998
Total Refined Sugars	9,939,847	7,337,492	5,322,407	3,867,198
Molasses	516,379	630,319	105,344	120,294
Total Imports	17,871,840	12,798,125	8,305,152	6,048,936

EXPORTS.

British Refined Sugars.	Cwts.	Cwts.	£	£
Sweden and Norway	18,288	9,747	10,724	5,079
Denmark	55,408	35,145	29,350	19,135
Holland	25,111	25,735	13,111	14,015
Belgium	3,809	3,378	2,017	1,648
Portugal, Azores, &c.	4,105	2,873	2,189	1,558
Italy	11,056	4,552	5,294	2,070
Other Countries	123,904	204,647	79,528	123,749
	241,681	286,077	142,193	167,254
Foreign & Colonial Sugars.				
Refined and Candy	18,785	13,092	11,751	8,297
Unrefined	27,500	23,873	14,375	12,374
Molasses	1,151	1,117	375	583
Total Exports	289,117	324,159	168,694	188,508

STOCKS OF SUGAR IN EUROPE AT UNEVEN DATES, JUNE 1ST TO 24TH, COMPARED WITH PREVIOUS YEARS.
IN THOUSANDS OF TONS, TO THE NEAREST THOUSAND.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	TOTAL 1903.
107	925	618	340	181	2172

	1902.	1901.	1900.	1899.
Totals	2311	1460	1301	1466

TWELVE MONTHS' CONSUMPTION OF SUGAR IN EUROPE FOR THREE YEARS, ENDING MAY 31ST, IN THOUSANDS OF TONS.

Great Britain.	Germany	France.	Austria.	Holland, Belgium, &c.	Total 1902-03.	Total 1901-02.	Total. 1900-01.
1542	849	561	408	513	3875	4114	4263

ESTIMATED CROP OF BEETROOT SUGAR ON THE CONTINENT OF EUROPE FOR THE CURRENT CAMPAIGN, COMPARED WITH THE ACTUAL CROP OF THE THREE PREVIOUS CAMPAIGNS.

(From Licht's Monthly Circular.)

	1902-1903. Tons.	1901-1902. Tons.	1900-1901. Tons.	1899-1900. Tons.
Germany	1,750,000	2,304,924	1,984,186	1,798,631
Austria	1,070,000	1,302,038	1,094,043	1,108,007
France	890,000	1,183,420	1,170,332	977,850
Russia	1,215,000	1,098,983	918,838	905,737
Belgium	230,000	334,960	393,119	302,865
Holland	105,000	203,172	178,081	171,029
Other Countries	345,000	393,236	367,919	253,929
	5,605,000	6,820,733	6,046,518	5,518,048

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1903. Tons.		1902. Tons.
Total Receipts, 1st Jan. to June 18th ..	876,472	..	689,957
Receipts of Refined ,, ,, ,, ..	734	..	6,525
Deliveries ,, ,, ,, ..	800,745	..	688,132
Consumption (4 Ports, Exports deducted) since 1st January	690,496	..	697,366
Importers' Stocks (4 Ports) June 17th ..	80,112	..	27,136
Total Stocks, June 24th	325,000	..	130,620
Stocks in Cuba ,, ...	344,000	..	422,290
	1902.		1901.
Total Consumption for twelve months ..	2,566,108	..	2,372,316

CUBA.

Statement of Exports and Stocks of Sugar, 1902 and 1903.

(Tons of 2,240lbs.)	1902. Tons.		1903. Tons.
Exports	238,703	..	492,653
Stocks	489,132	..	371,941
	727,835	..	864,594
Local Consumption (five months)	16,840	..	17,230
	744,675		881,824
Stock on 1st January	19,873	..	42,530
Receipts at Ports up to 31st May	724,802	..	839,294

J. Guma.—F. Mejer.

Havana, 31st May, 1903.

UNITED KINGDOM.

Statement of Imports, Exports, and Consumption for Three Years.

From *Produce Markets' Review.*

Sugar.	Imports. 1903. Tons.		Imports. 1902. Tons.		Imports. 1901. Tons.	Exports (Foreign). 1903. Tons.		Exports (Foreign). 1902. Tons.		Exports (Foreign). 1901. Tons.
Refined, Jan. 1st to May 31st.	366,874	..	496,992	..	512,840	654	..	939	..	1,933
Raw, ,, ,,	241,515	..	370,781	..	388,148	1,194	..	1,375	..	1,940
Molasses, ,, ,,	31,516	..	25,819	..	38,696	56	..	57	..	2,355
Total	639,905	..	893,592	..	939,684	1,904	..	2,371	..	6,228

	Home Consumption. 1903. Tons.		1902. Tons.		1901 Tons.
Refined, Jan. 1st to May 31st	343,401	....	499,221	....	—
Raw, ,, ,, ...	224,037	....	361,505	....	—
Molasses, ,, ,, ...	29,600	....	26,948	....	—
Total	597,038	....	887 674	....	—
Less Exports of British Refined	14,304	....	12,084	....	—
Net Home Consumption of Sugar	582,734	....	875,590	....	786,887*

* Trade estimate.

THE

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☞ The Editor is not responsible for statements or opinions contained in articles which are signed, or the source of which is named.

Demerara Crystals.

A curious case of the detection of "imitation Demerara" crystals was recently given in a letter in the *Times*. A gentleman who had a hive of bees, finding it necessary to feed the insects, bought some "Demerara" cane sugar, knowing they would like this best. He was therefore astonished to find that they turned this out of their hive, instead of eating it, although they could get no other food. A subsequent chemical analysis revealed that the sugar was imitation yellow crystals, probably from Germany. The action of the bees seems a remarkable testimony to the superior qualities of pure cane sugar over that of beet sugar. It is therefore to be hoped that the time may not now be long ere real Demerara crystals will be once more a regular article in the shops of every respectable grocer in this country; at present it is difficult to get them in most towns outside London.

British Machinery for Cuba.

We had occasion in our last number, when discussing the British fiscal position, to point out that Porto Rico, amongst other countries, was now a closed market for British engineers owing to the hostile tariffs imposed by the American authorities. We have since had a striking instance of what can be done, when British and American engineers compete under equal terms. A large triple-effet is required for the "Soledad" Estate in Cuba, and the American consulting engineers who were commissioned to secure the plant considered it would pay them to come over to Great Britian, both on account of price and also of superior construction and manufacture, as compared with American plant. The order was ultimately secured by Messrs. McOnie, Harvey & Co., of Glasgow. It will be one of Harvey's Patent Evaporators with special circulating arrangement, containing 8,000 sq. ft. of heating surface; the vessels will be 8 ft. 6 in. in

diameter and have a barometrical column with usual vacuum pumping engine, syrup pumps, juice and calandria drain, and centrifugal pump for injection water to barometrical condenser. One important point about this order should not be overlooked; that British engineers secured it was only rendered possible by the fact that they at present get into Cuba under the same terms as do their American rivals; once a reciprocity treaty is concluded between the United States and Cuba this equality of treatment will cease to exist, to the disadvantage of the British manufacturer. Yet some of our leading papers, the *Times* included, are disposed to join in the clamour for "Justice to Cuba," entirely overlooking the fact that whatever the quality of "justice" Cuba ultimately secures, our own country will suffer an *injustice*, inasmuch as she will be deprived of yet another large market.

It is surely obvious that if any given British manufactures are superior to the corresponding American ones, then it is a doubtful "justice" to Cuba to force on her hands an inferior article by means of a system of tariffs that shuts out the superior one. But that is her outlook. We scarcely suppose that our remarks on this particular aspect of the Cuban question will commend themselves to our American readers, and doubtless if it were the only one, they would be unanimous in favour of a reciprocity treaty. But the latter would adversely affect their own sugar industries, so that they are bound to both lose and gain in either case. Frankly we consider that Cuba is, under present conditions, far better off than she will be when entangled in the meshes of a reciprocity treaty, and we therefore hope that the latter will continue to be postponed *sine die*. As matters stand, it will require a special session of the American Congress, if the Bill to give effect to it is to be passed in the near future; this would have to assemble in the autumn.

The Sugar Bill.

The Bill to give effect to the Brussels Sugar Convention was introduced into the House of Commons on May 28th, and after some discussion, in the course of which it was vehemently opposed by Mr. Lough and Mr. Gibson Bowles, it passed its first reading by 142 votes to 82. It came up for its second reading on the 28th July. As is well known, its principal clause provides for the total prohibition of the importation of bounty-fed sugar, but, as pointed out by Mr. Bonar Law, it will only affect one-thirtieth of the total imports of sugar into the United Kingdom. The debate lasted two days, and the Bill was so fiercely opposed by certain free traders that up to the last hour things looked rather black. It was well for the Government that they had a man of such strong personality as Mr. Chamberlain to wind up the Bill on their behalf. The Opposition, entirely ignoring the views of such confirmed free traders as M. Yves Guyot and Sir M. Hicks Beach who declared that there was nothing in the measure that was not

consistent with the principles of real free trade, persisted in looking on it as the thin end of the wedge of protection. The most virulent opponent was a youthful member of the Government side; he raised so many side issues that the real question was in danger of being obscured. But Mr. Chamberlain soon brought about a change in the aspect of affairs; one after another of the arguments advanced against the Sugar Convention were refuted by him, and in the end the second reading was carried by the safe, if not substantial, majority of 80 (224-144). This result will surely come as a relief to the British and Colonial sugar industry; all the more so as it almost looked as if their hopes were once more to be dashed to the ground.

We note the reappearance in the debate of the old argument about the comparatively small amount of sugar produced by the West Indies. An obvious answer is that if Cuba at her best can produce over a million tons of sugar per annum, it ought not to be out of question for the British West Indies and British Guiana to produce a similar amount when all their available land is brought into use. We are giving them the inducement to increase their output—an inducement which has hitherto been entirely wanting. But, of course, it is too much to expect much change within the near future. Ruin that has been brought on by ten or twenty years of depression is not to be patched up in a few months.

THE CONFERENCE OF THE EUROPEAN SUGAR TRADES.

Statement of M. F. Sachs, Secretary to the Conference.

"The Conference has no intention to cause a rise of price in England. This would be the way to cause cane sugar producers to increase their cultivation and therefore eventually their production, injuring thus their own interests as well as those of the beetroot industry.

"On the other hand, the English consumers have no interest in seeing sugar fall in price below the cost of production. For that would result in the ruin of a great number of sugar factories, and the survivors, freed for the moment from all competition, would consequently be able to raise prices as they pleased. Then this rise would bring about a fresh competition, the price would fall again, and so on as before. This is the constant result of a game as hurtful to the merchant and consumer as it is to the manufacturer and farmer. We desire neither exaggerated rises nor exaggerated falls. We wish the production of sugar to be regulated in a rational way in accordance with the wants of consumption, and in such a manner as to avoid excessive fluctuations in value."

The above is translated from the *Journal des Fabricants de Sucre* of the 22nd July, 1903.

M.P.S AND CONFECTIONERS.

The report of the meeting of Confectioners and Members of Parliament at the Westminster Palace Hotel, on the 17th July, reveals such a series of erroneous ideas that it may be useful to point out briefly the errors into which the speakers have fallen.

The Chairman dwells on the importance of the subject because the trade had grown to enormous proportions owing to the introduction of cheap raw materials. He omits to notice that when bounties are abolished he will get sugar at the natural price as governed by the cost of production, a price which will be lower than the average price he has been paying during the long period of flourishing trade in British confectionery and jam. He also forgets that his own firm, Messrs. James Keiller and Son, addressed the following letter to Sir Nevile Lubbock in the year 1889. The argument in favour of the abolition of bounties could not be put more concisely:—

"27, Mincing Lane, London, E.C.,
"May 24th, 1889.

"Dear Sir,

"As large consumers of sugar, we trust the efforts of your Association will succeed in spreading the knowledge of facts bearing on the question of sugar bounties. The more widely they are known, and the better understood, the more evident will it appear that the abolition of bounties would not injure the fruit growing, fruit preserving, and confectionery trades of this country, but would confer a direct benefit on them by giving them an ultimately cheaper as well as a more regular and more reliable supply of sugar.

"More than a year ago we expressed this opinion to Mr. J. Duncan, and subsequent discussion and study of the question have served to confirm it. An international agreement on the sugar bounty question would be a blow to bounties of all kinds which might be applied to any trade, and those who are fortunate enough to bring negotiations on the subject to a successful issue will merit the gratitude of the working classes as well as the merchants and manufacturers of the country.

"We are, yours truly,
"(Signed) JAMES KEILLER & SON.

"N. LUBBOCK, Esq."

So much for the Chairman of the Meeting.

Mr. T. Gibson Bowles, M.P., moved the first resolution, and spoke of the Bill as "prohibiting supplies and raising the price of sugar."

The world produces about ten million tons of sugar, and we consume about 1,600,000 tons. It is possible, though not probable, that the penal clause may have to be enforced against one or two

countries exporting a few thousand tons of sugar; but how can this be fairly called "prohibiting supplies" when we have ten million tons to choose from? Look at the United States. They have a long list of countervailing duties against bounty fed sugar, and yet, at the present moment, sugar is cheaper in New York than it is in London. While that is the case, their countervailing duties are as effectual as prohibition, and yet they not only have no effect in raising prices, but even fail to prevent a remarkable difference in value in favour of the American buyer.

Mr. Bowles says, this country will be "placed under the orders of a permanent Commission, sitting at Brussels." To any reasonable person this would appear to be a step in the right direction, when eight or nine of the leading countries in Europe meet together in the most friendly spirit and discuss in a calm and business like way, and with full knowledge of the technical details, how to put a stop to what M. Yves Guyot rightly described as protection in its worst form, that of aggressive protection; and to promote what he regards as the greatest free trade measure since the treaty of 1860.

That this country will be compelled by the Commission to do anything which it disapproves is an absurd and unfounded insinuation.

The difference between the price of sugar in Berlin, Paris and London, has nothing to do with bounties, because the sugar trade in those three countries all buy their sugar practically in the same markets, and very nearly at the same market prices. The striking difference in price arises solely from the different rates of duty in the three countries. But Mr. Bowles declares that this difference of value is "in consequence of the now existing, but soon to be abolished bounties." This extraordinary fallacy is at the root of most of the opposition to the Convention. Sir William Harcourt, Lord Spenser and Sir Henry Campbell-Bannerman all repeat the cry, that the British consumer will loose 1,600,000 × 5 = £8,000,000 by the abolition of bounties; from which we must infer that they imagine that the bounty-fed producer presents British consumers with his £5 a ton. But Mr. Bowles goes much further when he asserts that bounties, are the cause of sugar being at 5d. per lb. in Berlin; 7½d. per lb. in Paris and only 1½d. per lb. in London. He therefore assumes that the maximum bounty of £5 per ton enables the British consumer to get sugar £32 13s. 4d. per ton cheaper than his German neighbours, and £56 per ton cheaper than the Paris consumer. It is as well, occasionally, to show the utter absurdity of the assertions of our opponents, even at the risk of being prosy. The bounty-fed producer never gives away any of his bounty till the over production has glutted the market, and forced values down below cost price; and then, whatever fraction he is obliged to give away he gives to his own consumers as well as to those of other countries. British producers at

the same time have to make the same present out of their own pockets. Consequently there is no force in the further assertion that "so long as it pleases any foreign country for its own purpose to dump down upon these shores cheap sugar, he should be allowed to do it." But there is every reason against such a doctrine. Natural production is driven out by the process of artificially stimulating over production, and the consumer suffers not only by the consequent reduced supply, but still more by becoming more and more dependent for his supply of sugar on an artificial and therefore precarious monopoly.

Mr. Lough, M.P., protests against doing "anything artificial in the way proposed." He is evidently unaware that the measure he opposes will restore natural competition by the abolition of artificial competition.

Mr. Fletcher Moulton, K.C., M.P., refers to a "private combination of continental countries to raise the price of sugar supplies to the United Kingdom." The facts are as follows: Bounties have caused such an over production that we now have a world's supply nearly a million tons in excess of what is wanted. The leaders of the beetroot industry on the continent are naturally desirous to remedy this by a reduction to a level with consumption. A most reasonable proposal which has absolutely nothing to do with what Mr. Fletcher Moulton laments over, unless he thinks that sugar ought to be produced below cost price for ever for the benefit of British consumers. A curious doctrine for a professed political economist. He then reverts to the old fallacy that three to four, or even six to eight, millions sterling are going to be sacrificed. He accuses the Government of "an act of political folly," but the folly appears to be all on the side of those who use such arguments and quote such figures.

Sir William Holland, M.P., complains that we are handing over our fiscal arrangements to a foreign Commission. Why should a Commission on which the British Government is represented be called "foreign?" Are we never to be allowed to meet our neighbours in friendly conclave without being accused of doing a deed of which "this country will bitterly rue the day?"

We have dealt with every argument, and the conclusion to be drawn from this little analysis is that our opponents have no arguments. But unfortunately their erroneous statements are much more readily swallowed by the man in the street than the real arguments in favour of the abolition of bounties. That is why it has taken thirty years to accomplish, and may even now be defeated by ignorant clap-trap.

In the paper "Disappearance of Reducing Sugar in Sugar Cane" which appeared in our Journal last month the name of "Arthur Given" should have been given instead of "A. W. Bache."

THE BRUSSELS SUGAR COMMISSION.

A Parliamentary paper has just been issued containing the "Findings of the Permanent Commission established under Article VII. of the Sugar Convention." It contains Sir Henry Bergne's report of the proceedings at Brussels:—

The Permanent Commission finds:—

"I.—*Spain.*

"That there exists a surtax of 60 fr. per 100 kilog. on sugars of every kind. The Commission has consequently fixed the special duty, contemplated by Article IV. of the Convention, on sugar of Spanish origin at 27 fr. per 100 kilog., in the event of the Government of that country, which has signed the said Convention, not having ratified it before the 1st September next.

"II.—*Denmark.*

"(*a.*) That the amount of the surtax is 9 fr. 54. c. per 100 kilog. of sugar, so that, in virtue of the provisions of the third paragraph of Article IV. of the Convention, the amount of the special duty to be applied in this respect to sugar of Danish origin is 1 fr. 77 c. per 100 kilog.

"(*b*) That there exists in this country bounties on refining, the amount of which (27 c. + 1 fr. 47 c. = 1 fr. 74 c.) must, according to the provisions of § 2 of Article IV. of the Convention, be added to the special duty in question.

"Consequently, the Commission has fixed the following rates for the special duties to be applied to sugar of Danish origin when imported into Contracting States:—

"1 fr. 75 c. per 100 kilog. for raw sugar; and
"3 fr. 50 c. ,, ,, refined sugar.

"III.—*Japan.*

"That the surtax on the importation of sugar which benefits by the import duties fixed by the Conventional Tariff enjoyed by all the Contracting States is not high enough to render necessary the application of countervailing duties on raw sugar and on the greater portion of refined sugar. This measure is only to be taken with regard to refined, candied sugar, which should be subject to a special duty of 2 fr. 61 c. per 100 kilog. (surtax: 11 fr. 22c. — 6 fr. = 5 fr. 22 c. ÷ 2 = 2 fr. 61 c.).

"IV.—*Roumania.*

"(*a.*) That there is a bounty on manufacture of 16 fr. per 100 kilog. of sugar.

"(*b.*) That the sugar industry enjoys, in addition, advantages resulting from a surtax of a rate higher than that fixed by Article III. of the Convention.

"With regard to the bounty on manufacture, the Commission has recognised that this bounty does not constitute a direct bonus, but that, in this special case, it acts as an element of reduction in the tax on consumption, which, instead of being 30 fr. per 100 kilog. of sugar as laid down by law, is in reality only 14 fr. (30 fr. — 16 fr.).

"As to the advantage resulting from the surtax, the Commission is of opinion that it should be calculated in the following manner:—

"Foreign sugar imported into Roumania is subject to the following import duties: 35 fr. per 100 kilog. on refined sugar and 25 fr. per 100 kilog. on raw sugar.

"Both classes are, besides, subject to the consumption tax of 30 fr., with the result that the total duty on refined sugar is 65 fr. and on raw sugar 55 fr.

"The consumption tax on sugar of home manufacture being, according to the above calculation, uniformly 14 fr. per 100 kilog., the advantage accruing under the surtax is in reality:—

"For refined sugar, 65 — 14 = 51 fr., and for raw sugar, 55 — 14 = 41 fr.

"Consequently, the Commission, guided by the provisions of Article IV. of the Convention, has fixed the figures of 22·50 fr. and 17·75 fr. respectively for refined and raw sugar as the rates of special duties to be applied to Roumanian sugar when imported into the Contracting States (surtax 51 — 6, the figure fixed by Article III. of the Convention = 45; whence 45 ÷ 2 = 22·50 fr., and surtax 41 — 5·50, the figure fixed by Article III. of the Convention = 35·50; whence 35·50 ÷ 2 = 17·75 fr.).

"V.—*Russia.*

"That the surtax on refined sugar is 69·03 fr. per 100 kilog. (import duty 97·68 fr. — 28·65 fr. consumption tax, license and supplementary tax on refining) and that on raw sugar is 44·69 fr. (import duty 73·26 fr. — 28·57 fr. comsumption tax and license).

"Consequently, the Commission has, in accordance with Article IV. of the Convention, fixed respectively at 31 fr. and at 19 fr. per 100 kilog. the special duties applicable to refined and raw sugar of Russian origin."

On July 10th, Sir Henry Bergne sent in a detailed report of the conclusion arrived at up to date. It contained the following:—

The duty of the Commission was, first, to examine the legislations of the Contracting States, in order to see if they were in conformity with the Convention; and secondly, to examine the legislations of Non-Contracting States, in order to see if they gave sugar bounties: if they did, to determine the amount of such bounties, and to make arrangements for the due application of the Penal Clause in the Contracting States.

(1.) *Legislation of the Contracting States.*

Germany.—The Commission was unanimous in deciding that the legislation of Germany was in harmony with the Convention.

Austria and Hungary.—The Commission was unanimous in deciding that the legislation of Austria and Hungary was in harmony with the Convention, except the so-called "Contingent Law."

As to this, the Commission decided unanimously, except Austria and Hungary (Italy did not vote), that it was inconsistent with the Convention, and it is consequently to be presumed that the laws of Austria and Hungary in this respect will be put into harmony with the Convention before it comes into effect.

France.—Several Delegations, viz., the British, Belgium, Austrian, and Dutch, showed to the Commission that the French law as to refining in bond did not provide the guarantees required by the Convention against ndirect bounties.

To explain—the correct system is—as in Germany and other countries—that the raw sugar is weighed when it enters the refinery, and the refined sugar is weighed when it leaves the refinery. The duty is then paid on the exact amount of refined sugar which goes for home consumption, and that for export is exported in bond, no duty being paid and no drawback being therefore required.

The French system, however, is as follows, as nearly as could be ascertained:—

When the raw sugar goes into the refinery it is weighed, and an estimate is made of the amount of refined it ought to give. The refiner is debited in the Government books with the tax leviable on the amount so estimated. The refined sugar is not weighed at all on leaving the refinery. The refined sugar which goes for export receives a "Certificat d'exportation," with which any amount standing to debit of the refiner in the Government books can be discharged; and as this certificate can be, and is, sold in the open market for a sum equal to the duty on the sugar represented thereon, it is clear that the grant of such certificate to the exporter is exactly the equivalent to the payment of drawback.

It is evident that such an arrangement fails to provide the international guarantee implied by a proper system of refining in bond.

In considering how the Commission should deal with this state of affairs, it had to consider that the French Chambers rise early in July, not to meet again till after the 1st September, when the Convention comes into effect, and that it would be impossible for France to change her whole legislative system as to refining in bond before the Session closed.

The Commission, therefore, adapted a formula to the effect that, though several delegations had shown the French system not to be in perfect harmony with the Convention, the matter was not urgent; but that the French Government would no doubt make the necessary modifications in the French Law.

Netherlands.—The legislation of the Netherlands was decided by a majority to be in harmony with the Convention.

Sweden and Italy.—These legislations were decided to be in harmony with the Convention.

Great Britain and Belgium had not yet passed their laws, and it was, therefore, not easy for the Commission to express decided opinions. I submitted our existing Law and our Bill, saying, however, that the latter might be altered in Parliament.

A few easily answered questions were asked, but no objections were made.

A cursory examination of the Belgian Bill was made in the same way No objection was found to it.

It may be added that it was recognised that all the decisions were not definite in character, but were subject to revision at future meetings of the Commission, if occasion should arise.

The Commission did not at this Session undertake any inquiry into the systems of the British Colonies or India.

Luxemburg applied to enter the Convention. The request was granted—their law being identical with that of Germany.

Peru made the same request. It was, however, found on examination that Peruvian law was not in harmony with the Convention, and it was decided to point this out to the Peruvian Government, and to await their reply.

(2.) *Legislation of Non-Contracting States.*

Some difficulty arose in consequence of no accurate information being before the Commission as to the legislation of some States which are believed to give bounties. The result was, that the Commission pronounced its opinion as to those countries in regard to which it had particulars before it, and decided that, as a provisional measure, the Contracting States might use the scale fixed by the United States, in regard to other bounty-giving States, until such time as the Commission should decide.

It was recognised that each Contracting State was not bound to enforce the penal clause in regard to any country until it was known that such country really sent an appreciable amount of sugar into such Contracting State. This decision may be regarded as of some importance, as it thus will not be necessary in the first instance to apply the Prohibitory Order in the United Kingdom to many foreign States.

The Commission had before it only the legislations of Spain, Denmark, Japan, Roumania, Russia, and the Argentine Republic. The decisions in regard to these cases have already been communicated to your Lordship in the Report of the Commission inclosed in Sir C. Phipps' despatch of 28th ultimo, except in regard to the Argentine Republic.

It only remains, therefore, to state that at the 14th and 15th sittings of the Commission, held on the 7th and 8th instant, it was decided that the figure fixed for Russia needed revision, and that, pending further consideration by the Commission, the Contracting States might apply the rate of countervailing duty fixed by the United States . . . .

A similar decision was arrived at in regard to the Argentine Republic.

It may be observed that in case prohibition should be imposed in the United Kingdom instead of countervailing duties, the exact rate fixed for each non-Contracting State is not a matter of immediate concern to Great Britain.

I annex returns of the importation into the United Kingdom of refined and unrefined sugars from 1898 to 1902:—

In regard to refined sugar, it must be noted that Germany, the Netherlands, Belgium, France, and Austria-Hungary, from which countries the bulk of our supply is received, are parties to the Convention. Of the others, I believe that Denmark is the only one which sends any bountied sugar to the United Kingdom, and that, as will be seen, to an inappreciable amount.

In regard to unrefined sugar, the same countries, of course, are parties to the Convention, again comprising the bulk of the supply. Egypt gives no bounties on sugar; the United States sends us no bountied sugar. The Commission had not before it any particulars respecting Brazil and the Philippine Islands, but no information has at present reached me to show that sugar bounties exist in those countries.

If, therefore, Peru should adhere to her intention to join the Convention, the only considerable sources of supply for the United Kingdom which would be affected by the operation of the Penal Clause, when the Convention comes into force, would be the Argentine Republic and Chili.

Certificates of Origin.

The Commission decided that certificates of origin must accompany all sugar imported into Contracting States, and at the 12th sitting the following Rules were laid down in regard to this matter:—

"Article 1. In order to insure the application of the Convention, all foreign sugar coming into a Contracting State to be there consumed, refined or transformed shall be accompanied by a certificate of origin. Sugar not accompanied by such a certificate shall not be admitted, or shall only be admitted on payment of the highest of the special duties fixed by the Permanent Commission.

"Article 2. Bounty-fed sugar shall be admitted in transit.

"Article 3. The transit contemplated in Article 2 shall only be effected under the control of the Customs, either directly or including transfer or storage in a bonded warehouse.

"Article 4. The certificate shall be delivered in the country of production, of despatch, or of transformation of the sugar by the fiscal authority to be appointed by the Government of that State.

"Nevertheless, the Government of the country for which the sugar is destined may, for greater safety, demand the additional guarantee of a Consular *visa*, so far as sugar coming from a non-Contracting State is concerned.

"Article 5. The certificates shall indicate:—

"(*a*.) The kind and quality of sugar.

"(*b*.) The kind, number and marks of the packages.

"(*c*.) The country of origin or of despatch, and the country for which the goods are destined.

"(*d*.) The method of transport (railway, ship, boat, &c.).

"These certificates shall be valid for a period of time to be fixed by the authority which delivers them, but not to exceed one year (exclusive of the time during which the sugar shall have been stored in a bonded warehouse).

"Article 6. With regard to sugar prepared in non-Contracting States, the certificate shall state, in addition, that it is derived from a factory which does not work sugar coming from a State to which a special duty or prohibition is applied.

"Article 7. The certificate shall become invalid if, in course of transport, the goods have been transhipped in a State which grants bounties. Exceptions may, however, be allowed in the case of unavoidable circumstances or when it is a case of sugar coming from Contracting States which is in transit through those countries under conditions which guarantee its identity."

It will be observed that these Rules leave a certain discretion to Contracting States as regards the actual form of the certificate, and as to the authority who may issue it. The requirement of a Consular *visé* is optional.

Sugar in Bond.

At the last sitting the Commission made the following decision:—

(*a.*) Sugars from non-Contracting States, which are in bond in Contracting States before the 1st September, may be taken out of bond after that date without the application of the Penal Clause. It is understood that the State into which the sugar is imported, is free, in such circumstances, to apply the Penal Clause or not.

(*b.*) All bountied sugars from non-Contracting States, which have not arrived in Contracting States before the 1st September, are subject to the application of the Penal Clause.

The Commission adjourned on the 8th instant until the 15th October next, having held fifteen sittings.

A RESTANT SOURCE OF ERROR IN OPTICAL SUGAR ANALYSIS.

By Dr. F. G. Wiechmann.*

The fact, that the presence of the precipitate formed in clarifying sugar solutions is a source of error which may prove very considerable, has been known for many years.

Without attempting to go into the history of this matter, it may be of interest to state that even in 1867 J. Welz published an article on this subject in the *Zeitschrift des Vereins für Rübenzucker Industrie*, Vol. 17, page 489. A glance through American, German, English, and French publications since that time shows that this question has frequently occupied the attention of investigators of these nationalities.

In making their experiments investigators have generally followed one of two methods; that of Scheibler or that of Sachs. Scheibler's Method of Double Polarisation described in the *Zeitschrift des Vereins für Rübenzucker Industrie*, 1875, Vol. 25, page 1054, is as follows: The normal weight of sugar is dissolved in distilled water; a measured amount of sub-acetate of lead solution is added, the volume is made up to a known volume, say 100 cc., with water, the solution filtered, and polarised.

*A paper read at the International Congress of Applied Chemistry, at Berlin, June, 1903.

A second solution is prepared in the same manner, except that its volume is made double the volume of the former solution; in other words, the volume of this solution is made up to 200 cc. and this solution is then also filtered and polarised.

Assuming that the volume of the lead precipitate formed in both cases is identical, it is evident that the polarisation of the more dilute solution must be somewhat less than one-half the polarisation of the more concentrated solution.

To make this clear, suppose the volume of the precipitate formed = 3 cc. In the first case the solution would occupy a space of 100 — 3 = 97 cc. In the second case, the solution would occupy a space of 97 + 100 cc. = 197 cc.

If the polarisation of the first solution (100 cc. in volume) is equal to x polariscope degrees, the polarisation of the second solution (200 cc. in volume) would be equal to $\frac{97}{197}\,x$ polariscope degrees.

The corrected polarisation would then be found in the following manner:—

Polarisation of Solution A (100 cc. in volume) .. .. } = 96·80

Polarisation of Solution B (200 cc. in volume) . .. . } = 48·25

$$
\begin{array}{ll}
48{\cdot}25 \times 2 \;\ldots\ldots\ldots & = 96{\cdot}50 \\
96{\cdot}80 & \\
\underline{96{\cdot}50} & \\
0{\cdot}30 \times 2 \;\ldots\ldots\ldots & = \;\;0{\cdot}6 \\
96{\cdot}8 \;-0{\cdot}6 \;\ldots\ldots\ldots & = 96{\cdot}2 \text{ Corrected Polarisation.}
\end{array}
$$

Of course the volume of the precipitate can also readily be calculated from these data.

$$A - (B \times 2) = D, \text{ and}$$

$$\frac{D \times 200}{A + D} = \text{Volume of Precipitate.}$$

Example: $A = 96{\cdot}8$

$B = 48{\cdot}25$

$$96{\cdot}8 - (48{\cdot}25 \times 2)$$

$$96{\cdot}8 - 96{\cdot}5 = 0{\cdot}3$$

$$\frac{0{\cdot}3 \times 200}{96{\cdot}8 + 0{\cdot}3} = \frac{60}{97{\cdot}1} = 0{\cdot}6.$$

Hence the volume of this precipitate is 0·6 cc.

This method of double polarisation is, however, open to several objections. When working with raw sugar, especially with low-grade cane products, it is almost impossible to secure absolutely identical samples for comparison in the two series of observations. But even if this difficulty could be overcome, for instance, by weighing out

double the amount of sugar at the start, yet the doubling of the polariscope reading involves the material enlargement of any experimental error that may have been made.

To avoid the defects of this method, François Sachs, at the suggestion of Dr. K. Stammer, undertook to devise some other way of ascertaining the influence which the lead-precipitate exerts on polarisation. He published an article bearing on this subject in the *Zeitschrift des Vereins für Rübenzucker Industrie*, 1880, Vol. 30, page 229.

Sachs' method consists essentially of the following: A precipitate is produced by sub-acetate of lead. This precipitate is washed with cold and with hot water until all of the sucrose is removed, and is then introduced into a 100 cc. flask. A one-half normal weight of pure sugar is added, dissolved, and the solution is made up to 100 cc. with distilled water.

This solution is then well mixed, filtered, and polarised, and the volume of the precipitate ascertained in the following manner:—

$A =$ Percentage of purity of the sucrose in the solution.

$B =$ Polarisation of this solution when containing the precipitate.

$V =$ Volume of the precipitate is equal to $\dfrac{100\,B - 100\,A}{B}$.

Example: $A = 99{\cdot}90$

$B = 100{\cdot}30$

$$V = \frac{(100 \times 100{\cdot}3) - (100 \times 99{\cdot}9)}{100{\cdot}3} = \frac{400}{1003} = 0{\cdot}4 \text{ cc.}$$

In the course of this investigation, undertaken by the writer of these lines for the purpose of obtaining exact analytical data on certain cane sugars, a number of determinations were made by both the Scheibler and the Sachs' method. In each instance only just enough sub-acetate of lead was used to ensure a proper decolorisation of the sugar solution—the slightest excess of reagent was carefully avoided.

The data secured were as follows:—

Experiment No.	Grade of Sugar.	Polarisation found.	Volume of precipitate.	Method used.
1	Demerara centrifugal	96·8	0·6	Scheibler.
2	,, ,,	96·7	0·5	Sachs.
3	San Domingo centrifugal	96·1	0·5	,,
4	Cuba centrifugal	91·8	0·4	,,
5	Cuba molasses	90·0	0·6	,,
6	Ilo-Ilo mats	89·5	1·1	Scheibler.
7	Jamaica muscovado	86·8	0·3	Sachs.
8	Maceio	86·1	0·9	,,
9	Molasses	83·1	1·0	Scheibler.
10	Cuba muscovado	82·7	0·7	Sachs.
11	Bahia	76·6	1·0	Scheibler.

The results obtained exhibited such marked differences for sugars of different origin, but of approximately the same polarisation, that

it seemed desirable to secure additional data and, incidentally, to seek some indications as to the physical characteristics of the precipitates found in different grades of sugar.

This part of the work was carried on in the following manner:—

A solution of sub-acetate of lead was prepared in exact accordance with the directions of the International Commission for Uniform Methods of Sugar Analysis.

A normal weight-solution of the raw sugar to be examined was then made and the minimum amount of sub-acetate of lead solution needed for its proper clarification was carefully determined by experiment.

The lead precipitate thus obtained was filtered on a weighed Schleicher & Schüll filter and washed with cold and with hot water until the alpha-naphthol reaction for sucrose could no longer be obtained. Then the precipitate was dried to constant weight at 100° C.

Preliminary experiments having shown that pure benzene exercised no solvent action upon the precipitate, the specific gravity of the same was determined by aid of this reagent and then referred to the water standard. The specific gravity of the benzene employed was 0·6845.

The colonial sugars selected for these experiments embraced centrifugals from San Domingo and the Sandwich Islands, muscovadoes from the West Indies, molasses sugars from Porto Rico, concretes from San Domingo, and mats from Manila and Cebu.

The analytical data of these sugars appear in the following table:—

Experiment No.	Sugar.	Polarisation.	Reducing sugars.	Water.	Ash.	Suspended impurities.	Non-ascertained.
12	Jamaica muscovado	90·1	1·61	5·02	0·68	0·20	2·39
13	Maceio muscovado	85·4	4·35	5·60	0·75	1·06	2·84
14	San Domingo centrifugal	96·5	0·67	1·20	1·36	0·06	1·21
15	Sandwich Islands	97·6	0·45	0·60	0·40	0·04	0·91
16	San Domingo concrete	85·2	2·91	4·92	1·68	0·30	4·99
17	Porto Rico molasses	88·4	3·17	3·66	1·36	0·28	3·13
18	Sandwich Islands	89·2	1·60	2·58	2·19	0·20	4·23
19	Cebu mats	82·4	6·75	2·60	2·17	0·76	5·32
20	Manila mats	86·8	4·14	1·96	0·92	1·80	4·38

The weight, the specific gravity and the volume of the precipitates obtained from these sugars are listed below.

PRECIPITATES.

Experiment No.	Sugar.	Weight in grammes.	Specific gravity $H_2O = 1·000$.	Volume in cc.
12	Jamaica muscovado	0·4559	1·88	0·24
13	Maceio muscovado	0·8112	1·65	0·49
14	San Domingo centrifugal	0·2525	2·91	0·09
15	Sandwich Island centrifugal	0·1578	2·84	0·05
16	San Domingo concrete	1·0139	3·80	0·27
17	Porto Rico molasses sugar	0·8959	4·35	0·21
18	Sandwich Islands	1·0195	4·38	0·23
19	Cebu mats	1·5400	2·17	0·71
20	Manila mats	1·3350	2·22	0·60

Inspection of these data shows well how greatly the composition of the impurities in the different kinds of cane sugars must vary, for the specific gravities of these precipitates differ widely, from 1·65 to 4·38.

In this connection it is of interest to recall the specific gravity values obtained by Sachs of some lead salts of organic acids. Among these were the citrate, tartrate, oxalate, and carbonate of lead, and their specific gravity values were found to range from 3·05 to 6·27.

Another matter of interest to be noted is the fact that the most voluminous precipitates are not always found in low-grade sugars.

Thus, precipitates almost identical in volume were obtained from sugars differing materially in quality.

No.	Polarisation.	Volume of Precipitate.
12	90·1	0·24
18	89·2	0·23
17	88·4	0·21
16	85·2	0·27

To determine the extent to which polarisations might be influenced by the forming of lead compounds having specific optical properties, a complete set of parallel determinations was carried out with sugars No. 12—20.

In these tests a few drops of acetic acid were added after the subacetate of lead solution had been used. In only three instances, however, were polarisation-values observed differing from those previously found, and in no instance did such difference exceed 0·1°. The former were therefore retained.

The corrected polarisations (corrected for the error caused by the presence of the lead precipitate) were calculated in the following manner:—

Let $A =$ Per cent. of sucrose in the solution.

$B =$ Polarisation of this solution when containing the precipitate.

$V =$ Volume of this precipitate.

$$V = \frac{100\,B - 100\,A}{B}.$$

$$BV = 100\,B - 100\,A.$$

$$100\,A = 100\,B - BV.$$

$$A = \frac{100\,B - BV}{100}.$$

Example: $B = 90{\cdot}10°$ Ventzke.

$V = 0{\cdot}24$ cc.

$$A = \frac{(90{\cdot}10 \times 100) - (90{\cdot}1 \times 0{\cdot}24)}{100}.$$

$$A = \frac{9010 - 21{\cdot}624}{100}.$$

$$A = \frac{8988{\cdot}376}{100} = 89{\cdot}88,$$

and this is the value sought.

POLARISATION.

Experiment No.	Sugar.	Observed.	Corrected.	Diff.
1	Demerara centrifugal	96·80	96·22	0·58
2	,, ,,	96·70	96·22	0·48
3	San Domingo centrifugal	96·10	95·62	0·48
4	Cuba centrifugal	91·80	91·43	0·37
5	Cuba molasses	90·00	89·46	0·54
6	Jlo Jlo-mats	89·50	88·52	0·98
7	Jamaica muscovado	86·80	86·54	0·26
8	Maceio	86·10	85·33	0·77
9	Molasses	83·10	82·27	0·83
10	Cuba muscovado	82·70	82·12	0·58
11	Bahia	76·60	75·83	0·77
12	Jamaica muscovado	90·10	89·88	0·22
13	Maceio muscovado	85·40	84·98	0·42
14	San Domingo centrifugal	96·50	96·41	0·09
15	Sandwich Islands centrifugal	97·60	97·55	0·05
16	San Domingo concrete	85·20	84·97	0·23
17	Porto Rico molasses sugar	88·40	88·21	0·19
18	Sandwich Islands	89·20	88·99	0·21
19	Cebu mats	82·40	81·81	0·59
20	Manila mats	86·90	86·37	0·53

In these sugars therefore, the observed error caused by the presence of the lead precipitate ranges from 0·05° to 0·98° Ventzke.

It is difficult to understand how so serious, so well-known, a defect of polariscopic analysis should have been allowed to remain unto this day.

No doubt, the difficulty of determining a proper correction factor has been the chief cause of delay in seeking a remedy for this evil. Aside from this, however, there is a very general, even if a very vague impression, that there are certain other sources of error inherent in the methods of saccharimetric analysis which, as it were, tend to counteract this plus error in polarisation; a false sense of security has been engendered, a feeling that, after all, the results obtained will about balance in the long run.

Whatever the grounds on which such delusive reasoning may have been based in the past, to-day there is no longer any excuse for such an assumption. The analytical methods formulated by the International Commission in 1900, carefully eliminate the influence which would lower the test.

It is well known that readings of sugar solutions obtained in a saccharimeter when the saccharimeter is at a temperature above the temperature at which the instrument has been graduated, are slightly lower than are the readings of such solutions when obtained at the graduation temperature of the instrument.

This phenomenon is due to the influence which an elevation of temperature exercises in the quartz-wedges of the saccharimeter—these quartz-wedges are expanded by a rise in temperature.

This cause of disturbance can and, of course, should be wholly eliminated by adjusting the saccharimeter with a pure sugar solution, at the temperature at which the readings are to be made. Or, if numerous sugar solutions are to be tested at various temperatures, it may perhaps prove more convenient to make the necessary correction for this error by calculation.

This is effected by use of the so-called Jobin formula, which reads:

$$\text{Polarisation} + (0\cdot00016\,T)\,N.$$

In this formula T stands for the difference in temperature at which the sugar solution is prepared and polarised, and the temperature at which the saccharimeter has been graduated; N stands for the saccharimeter degrees of the sugar solution examined.

In the commercial analysis of sugars, this correction is generally not made. It is not made because it is held to offset—in a measure—the plus error due to the presence of the lead precipitate in the solution.

That the one error will, in part, counterbalance the other is obvious. It seemed, however, of interest to learn something of the actual numerical relations existing between the two.

To gain this information, it was necessary to obtain reliable temperature data as a basis.

The mean annual temperature for Boston, New York, Philadelphia, and San Francisco, four of the principal ports of entry for sugar in the United States of America, was:—

	In 1901. C.	In 1902. C.
Boston	9·45°	9·78°
New York	11·28°	11·45°
Philadelphia	12·11°	12·33°
San Francisco	12·89°	13·00°

For these data the writer is indebted to the courtesy of the U.S. Weather Bureau, at Washington, D. C.

All of these temperatures are considerably below 20° C., the standard temperature adopted by the International Commission for the graduation of saccharimeters. The actual temperature conditions under which polariscopic determinations of sugars are made of course differ materially from these temperatures.

In order to obtain accurate data on this point the writer caused three observations a day to be made in his laboratory, at 8 a.m., at 12 m., and at 3 p.m. These observations were carried on for two years during 1901 and 1902. The averages of these observations, monthly and annual, are noted in the following table:—

	1901.		1902.		1903.
January	—	....	22·4	....	22·4
February	21·0	....	21·6	....	—
March	22·5	....	22·6	....	—
April	22·4	....	23·1	....	—
May..	22·3	....	23·5	....	—
June	26·0	....	26·0	....	—
July..	27·7	....	27·7	....	—
August	27·9	....	27·2	....	—
September	26·0	....	25·6	...	—
October	23·3	....	23·7	....	—
November	22·7	....	23·1	....	—
December	23·5	....	22·1	....	—
Average	24·12	....	24·05	....	—

Although fluctuations are to be noted in some of the corresponding months in the two years, yet there is not 0·1° C. difference between the mean annual averages of the two years. In 1901 for eleven months this value was 24·12° C., in 1902 it was 24·05° C. It will therefore be practically correct to say that all tests made in both of these years were made at a temperature—on an average—of 4·1° C., above the standard temperature of 20° C.

Referring to Jobins' formula it will be seen that the correction to be applied for 4·1° Centigrade temperature is calculated by the expression :—

0·000656 × Degrees Ventzke.

Doing this the following correction factors result :—

Experiment No.	Degree Ventzke.	Experiment No.	Degree Ventzke.
1	0·063	11	00·50
2	0·063	12	0·059
3	0·063	13	0·056
4	0·060	14	0·063
5	0·059	15	0·064
6	0·059	16	0·056
7	0·057	17	0·058
8	0·056	18	0·058
9	0·054	19	0·054
10	0·054	20	0·057

As in these experiments the saccharimeter was purposely not adjusted for the higher temperature (average = 24·1° C.) the observed volume error, caused by the presence of the lead precipitate, has already been diminished by the quartz-wedge error; the former, the plus error, must therefore be increased by the amounts just calculated in order to learn its true extent.

This leads to the following data :—

Experiment No.		Plus error.		Minus error.		Excess of Plus error.
1	....	0·643	....	0·063	...	0·580
2	....	0·543	....	0·063	....	0·480
3	....	0·543	....	0·063	....	0·480
4	....	0·430	....	0·060	...	0·370
5	....	0·599	....	0·059	....	0·540
6	....	1·039	....	0·059	....	0·980
7	....	0·317	....	0·057	....	0·260
8	....	0·826	....	0·056	....	0·770
9	....	0·884	....	0·054	....	0·830
10	....	0·634	....	0·054	....	0·580
11	....	0·820	....	0·050	....	0·770
12	....	0·279	....	0·059	....	0·220
13	...	0·476	....	0·056	....	0·420
14	....	0·153	....	0·063	....	0·090
15	....	0·114	....	0·064	....	0·050
16	....	0·286	....	0·056	....	0·230
17	....	0·248	....	0·058	....	0·190
18	....	0·268	....	0·058	...	0·210
19	....	0·644	....	0·054	....	0·590
20	....	0·587	....	0·057	....	0·530

Inspection of these figures shows, that—considering all results—the plus error exceeds the minus error by from 0·05° to 0·98° Ventzke, on an average by 0·46° Ventzke.

If the data secured by the Scheibler method (Nos. 1, 6, 9, 11) be eliminated as possibly not equally trustworthy with the rest, then the plus error is found to exceed the minus error by from 0·05° to 0·77° Ventzke, on an average by 0·38° Ventzke.

The practice universally followed in commercial sugar testing—at least up to the introduction of the methods of the International Commission in 1900—the ignoring of the quartz-wedge error because allowance is not made for the error induced by the presence of the lead precipitate, is thus seen to be perfectly justified by the actual state of affairs.

In fact, as matters stand at present, it is evident that the Commission's regulations guarding, as they most properly do, against a lowering of test by the influence of temperature on the quartz-wedges of the polariscope, aggravate, unintentionally, it is true, but nevertheless effectively, the evil resulting from the presence of the lead precipitate formed in clarifying the solution.

It will be remembered that the average excess of the plus error over the minus error was found to be 0·38° Ventzke. In commercial practice this figure would rather be apt to be higher than lower, for whereas in these experiments scrupulous care was taken to avoid all

excessive additions of clarifying reagents, such care and precaution would and could hardly be taken in ordinary routine work.

On the other hand, the grade of raw cane sugars received would vary considerably in different years. If high grade sugars should predominate the magnitude of the volume error would be decreased, if low grade sugars were purchased in greater quantity than usual, the error would assume larger proportions.

Considering all things, it will probably be rather below than above the truth to assume 0·25° Ventzke as the average plus factor of error caused in cane sugars by the presence of the lead precipitate.

This error also affects beet products, but to a less degree; Scheibler in 1875, evaluated it at 0·15% to 0·20%, with a leaning toward the lower figure. This emphasizes the conservativeness of the figure 0·25% at which the writer has placed it for cane sugars; as before said, in all probability the error is greater than this.

But, whatever the extent of the error, the harm it works seems of sufficient importance to call for immediate and careful consideration with a view to its abatement.

Broadly speaking, two courses present themselves which might be followed to achieve this purpose.

On the one hand, the extent of the error, under various conditions, might be determined and a correction therefore introduced. On the other hand, search might be made for some reagent or reagents whereby decolorisation of sugar solutions could be secured without the formation of any precipitate and, of course, without affecting the optical properties of the sucrose solution.

Either course, whichever might be chosen, would necessitate a very considerable amount of work; of this the writer is thoroughly aware from his own tentative efforts along both of these lines of investigation.

Still, "before there can be applied science, there must be science to apply." It would therefore seem most proper to place this matter officially before the International Commission for Uniform Methods of Sugar Analysis.

This the writer would hereby do, and, in so doing, he would express the hope that this International Commission will charge itself with the devising and the introduction of a method in which this grave defect may be entirely avoided, a method to which the Imprimatur of this Commission may unhesitatingly be given.

Blyth Bros. & Co., Mauritius, report shipments of sugar from August 1st to June 26th as 143,775 tons, against 144,465 tons in the corresponding period of 1901-2.

The Colonial Sugar Refining Co., Sydney, at their half-yearly meeting, on April 30th last, submitted a report which showed a profit of over £100,000. A dividend at the rate of 10% per annum was adopted and £63,109 carried forward. All their refineries have been kept busily at work.

DEDUCTION OF FORMULÆ FOR CALCULATION OF CAPACITIES AND HEATING SURFACES OF SINGLE OR MULTIPLE EFFECTS.*

By Edw. P. Eastwick, Jr., C.E., Ph.B.

While making some calculations recently with reference to the proportioning of the steam and pumping plants for a sugar factory, the writer had occasion to refer to formulæ for computing the capacities and heating surfaces of the different bodies of a double, triple, and quadruple effect, and, on comparison of the results obtained by using the generally accepted formulæ given by Hugo Jelinek, E. Péclet, and M. Paul Horsin Déon, so great a variation was found in the values, as determined by the different formulæ, that he was led to take up a careful study of the mathematical deductions of these formulæ, the outcome of which has been to bring him to the conclusion that serious errors have been allowed to enter into all of the formulæ, making them inaccurate, and so much so that, in some cases, their use in computations would give misleading results not at all in accordance with facts.

The double, triple, and quadruple effects under consideration had 8 ft. diameter bodies with 2,000 sq. ft. of heating surface in the first body, and, assuming the average temperature of boiling in last body at 140° Fahr., it was desired to ascertain the following:—

First, the theoretically correct heating surfaces for the second body of the double effect, for the second and third bodies of the triple effect, and for the second, third, and fourth bodies of the quadruple effect, which should be such that the difference between the temperature of heating steam and the temperature of boiling would be the same for each body of the apparatus;

Second, the total quantity of a sugar solution, of 12° Brix, entering the apparatus at 150° Fahr., which would be concentrated, in unit time, to 54·3° Brix, assuming the steam pressure in the first body to be $5\frac{1}{3}$ lbs. above atmospheric pressure;

Third, the quantity of water evaporated, in unit time, in each body of the apparatus:

Fourth, the quantity of steam, of given pressure, required to do the work, or which would be condensed in the steam chamber of the first body, in unit time.

For our present purpose it will be sufficient to take up only the calculations for the double effect, these being the simplest.

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*Owing to a difference of opinion we have had with the Author, it is advisable to point out here that in this paper the decimal is represented by a point placed about the middle (·5). This is the usual method in English ractice and it is never placed on the line as appears to be done in some other countries.

According to Hugo Jelinek*, following E. Péclet, when the effect of all losses of heat is neglected, the quantity of steam required to operate a multiple effect at full capacity evaporating sugar solutions, or, in other words, the steam condensed in the steam chamber of the first body, and likewise the heating vapour condensed in any body, is given by the formula:†

$$Dg_x = \frac{H_x}{L_x} \qquad \text{(a)}$$

in which, according to English measure:

Dg_x = Quantity of heating steam condensed in unit time, lbs.,

L_x = Latent heat of the steam $= \begin{cases} 1115{\cdot}2 - {\cdot}708T_x, \text{ B.T.U., English Measure,} \\ 607{\cdot}0 - {\cdot}708T_x, \text{ Calories, Metric System,} \end{cases}$

$H_x = F_x a\,(T_x - \theta_x)$,

and in the latter two quantities:

F_x = Heating surface of body, sq. ft.,

a = Mean coefficient of heat transmission for entire heating surface of apparatus, B.T.U. (heat transmitted per sq. ft. in unit time, for one degree, Fahr., difference of temperature),

θ_x = Temperature, Fahr, of liquid boiling in body,

T_x = Temperature, Fahr., of heating steam of body.

Substituting these values of L_x and H_x, and representing Dg_x by Q_x, formula (a) becomes:

$$Q_x = \frac{F_x a\,(T_x - \theta_x)}{1115{\cdot}2 - {\cdot}708T_x} \qquad \text{(b)}$$

Jelinek also gives the following formula for calculating the water evaporated in any body of an effect:

$$Wg_x = \frac{H_x}{\lambda_x - (t_x - 32)}\S \qquad \text{(c)}$$

in which

Wg_x = Quantity of water evaporated in body in unit time, lbs.,

t_x = Temperature, Fahr., of liquid entering body,

λ_x = Total heat of vapour evaporated under constant pressure $= \begin{cases} 1081{\cdot}4 + {\cdot}305\theta_x \text{ B.T.U.,} \\ 606{\cdot}5 + {\cdot}305\theta_x \text{ Calories,} \end{cases}$

and H_x = same as above.

Substituting these values of λ_x and H_x, and representing Wg_x by p_x, formula (c) becomes:

$$p_x = \frac{F_x a\,(T_x - \theta_x)}{1081{\cdot}4 + {\cdot}305\theta_x - (t_x - 32)} \qquad \text{(d)}$$

and from this,

$$F_x = \frac{p_x\,[1081{\cdot}4 + {\cdot}305\theta_x - (t_x - 32)]}{a\,(T_x - \theta_x)} \qquad \text{(e)}$$

M. Paul Horsin Déon‖ gives the following formulæ for calculating the quantity of heating steam condensed in the steam chamber of any

* "Essay on the Construction of Evaporating Apparatus, &c.," by Hugo Jelinek.

† Letters representing quantities in Jelinek's formulæ have been changed from original for convenience in comparing them with formulæ following hereinafter.

§ Since this formula is expressed in temperature Fahrenheit in place of Centigrade, $(t_x - 32)$ is substituted for t_x.

‖ "Treatise on Sugar Making and Evaporation," by M. Paul Horsin Déon.

body of a multiple effect when evaporating sugar solutions, all losses of heat being neglected:

First.—When the temperature of juice entering a body is less than the temperature of boiling in body:—

$$Q_x = \frac{p_x\left[A+B\theta_x-s_x(\theta_x-32)\right]\left[T_x-\frac{\theta_x+t_x}{2}\right]+(T_x-\theta_x)(\theta_x-t_x)G_xs_x{}^*}{\left[T_x-\frac{\theta_x+t_x}{2}\right]\left[A+BT_x-(\theta_x-32)\right]} \quad (f)$$

and for the heating surface required for the body:

$$F_x = \frac{p_x\left[A+B\theta_x-s_x(\theta_x-32)\right]\left[T_x-\frac{\theta_x+t_x}{2}\right]+(T_x-\theta_x)(\theta_x-t_x)G_xs_x}{D(T_x-\theta_x)\left[T_x-\frac{\theta_x+t_x}{2}\right]\left[A+BT_x-(\theta_x-32)\right]} \quad (g)$$

and from (g):

$$p_x = \frac{F_xD(T_x-\theta_x)\left[T_x-\frac{\theta_x+t_x}{2}\right]\left[A+BT_x-(\theta_x-32)\right]-(T_x-\theta_x)(\theta_x-t_x)G_xs_x}{\left[T_x-\frac{\theta_x+t_x}{2}\right]\left[A+B\theta_x-s_x(\theta_x-32)\right]} \quad (h)$$

Second.—When the temperature of the juice entering a body is the same as the temperature of boiling in body:

$$Q_x = \frac{p_x[A+B\theta_x-s_x(\theta_x-32)]}{A+BT_x-(\theta_x-32)} \quad (f_b)$$

and for the heating surface required for the body:

$$F_x = \frac{p_x[A+(B\theta_x-s_x(\theta_x-32]}{D(T_x-\theta_x)[A+BT_x-(\theta_x-32)]} \quad (g_b)$$

and from (g_b):

$$p_x = \frac{F_xD(T_x-\theta_x)[A+BT_x-(\theta_x-32)]}{A+B\theta_x-s_x(\theta_x-32)} \quad (h_b)$$

Third.—When the temperature of juice entering a body is greater than the temperature of boiling in body:

$$Q_x = \frac{p_x[A+B\theta_x-s_x(\theta_x-32)][(A+BT_x-\theta_x-32)]-(A+B\theta_x)(t_x-\theta_x)G_xs_x}{[A+BT_x-(\theta_x-32)]^2} \quad (f_c)$$

and for the heating surface required for any body:

$$F_x = \frac{p_x[A+B\theta_x-s_x(\theta_x-32)][(A+BT_x-\theta_x-32)]-(A+B\theta_x)(t_x-\theta_x)G_xs_x}{D(T_x-\theta_x)[A+BT_x-(\theta_x-32)]^2} \quad (g_c)$$

and from (g_c):

$$p_x = \frac{F_xD(T_x-\theta_x)[A+BT_x-(\theta_x-32)]^2+(A+B\theta_x)(t_x-\theta_x)G_xs_x}{[A+B\theta_x-s_x(\theta_x-32)][A+BT_x-(\theta_x-32)]} \quad (h_c)$$

in which, according to English Measure:

Q_x = Quantity of heating steam condensed in unit time, lbs.,
G_x = Quantity of original liquid entering body in unit time, lbs.,
p_x = Quantity of water evaporated in body in unit time, lbs.,
θ_x = Temperature, Fahr., of liquid boiling in body,
T_x = Temperature, Fahr., of heating steam,
t_x = Temperature, Fahr., of liquid entering body,

* Letters representing quantities in formulæ have been changed to correspond with letters representing like quantities in previous formulæ and for the same reason.

$A = 1081 \cdot 4$,
$B = 0 \cdot 305$,
s_x = Mean specific heat of liquid in body,
D = Quantity of steam condensed per unit of surface, in unit time, for one degree Fahr. difference in temperature of heating steam on one side of condensing surface, and liquid being heated on the other side, lbs.,
F_x = Heating surface of body, sq. ft.

Let us now make the calculations for the double effect under consideration according to these two sets of formulæ, and, in order to simplify the work, let us assume the liquid in all of the bodies to have the same specific heat as water, and the same temperature of boiling under equal pressure. This assumption is allowable, as it will not affect the relative results obtained by the different formulæ.

We have assumed the pressure of the heating steam to be $5\frac{1}{3}$ lbs. above atmospheric pressure, which corresponds to a temperature of approximately 228° Fahr., and, since the temperature of boiling in the last body is 140° Fahr., and the difference between the temperature of the heating steam and the temperature of boiling is the same for each body, this latter difference equals $\frac{228 - 140}{2} = 44$. Furthermore, since the temperature of saturated steam is the same as the water from which it is generated,* and it follows from the construction of a multiple effect that the vapour of evaporation in any body is likewise the heating steam for the following body, neglecting the effect of any loss of heat, the temperature of boiling in the different bodies of the apparatus will then be:

No. of Body.	Temperature (Fahr.) Boiling Liquid.	Heating Steam.
1† ..	$\theta_I = 228 - 44 = 184°$ ..	$T_I = 228°$
2 ..	$\theta_{II} = \theta_I - 44 = 140°$ ..	$T_{II} = \theta_I = 184°$

Taken up in the order of our inquiry, the information first desired is the heating surface required for the second body of the double effect. The formulæ for the calculation, according to Jelinek and Déon, respectively, are: –

$$F_x = \frac{p_x[1081 \cdot 4 + \cdot 305\theta_x - (t_x - 32)]}{\alpha(T_x - \theta_x)} \qquad (e)$$

and

$$F_x = \frac{p_x[A+B\theta_x-s_x(\theta_x-32)][A+BT_x-(\theta_x-32)]-(A+B\theta_x)(t_x-\theta_x)G_x s_x}{D(T_x - \theta_x)[A + BT_x - (\theta_x - 32)]^2} (g_e)‡$$

But in each of these formulæ there are factors which, at present, are of unknown value, and cannot be directly calculated from data in

* The vapours of sugar solutions, being pure water, are usually considered to have the same temperature as water boiling under the same pressure, irrespective of the temperature at which the liquid boils.

† The first body is considered to be the one into which the juice and steam first enter.

‡ In this case the temperature of liquid entering second body is greater than temperature of boiling.

hand; thus p_x, representing the quantity of water evaporated in the body, appears in both the formulæ, and G_x, representing the total quantity of the original liquid entering the first body of the apparatus, appears also in the second formula, consequently it is impractical to make use of either of the formulæ until the values of the unknown quantities become known, and other formulæ for F_x must, therefore, be sought, in which all quantities are known. These will be derived directly from the formulæ for Q_x.

The formulæ of Jelinek and Déon for calculating Q_x, when all losses of heat are neglected, have been given above, and collected together, are:

(Jelinek)—When $\theta_x > < t_x$:

$$Q_x = \frac{F_x a (T_x - \theta_x)}{1115 \cdot 2 - \cdot 708 T_x} \qquad \text{(b)}$$

(Déon)—When $\theta_x > t_x$:

$$Q_x = \frac{p_x\left[A + B\theta_x - s_x(\theta_x - 32)\right]\left[T_x - \frac{\theta_x + t_x}{2}\right] + (T_x - \theta_x)(\theta_x - t_x) G_x s_x}{\left[T_x - \frac{\theta_x + t_x}{2}\right]\left[A + BT_x - (\theta_x - 32)\right]} \qquad \text{(f)}$$

When $\theta_x = t_x$:

$$Q_x = \frac{p_x [A + B\theta_x - s_x(\theta_x - 32)]}{A + BT_x - (\theta_x - 32)} \qquad (f_b)$$

When $\theta_x < t_x$:

$$Q_x = \frac{p_x [A + B\theta_x - s_x(\theta_x - 32)][A + BT_x - (\theta_x - 32)] - (A + B\theta_x)(t_x - \theta_x) G_x s_x}{[A + BT_x - (\theta_x - 32)]^2} \qquad (f_c)$$

The several formulæ of Déon, however, may be put in a simpler and common form, for formulæ (h), (h_b), and (h_c) give values for p_x, which, substituted in formulæ (f), (f_b), and (f_c), respectively, reduces each of them to—

$$Q_x = F_x D (T_x - \theta_x) \qquad \text{(i)}$$

and, since D represents the quantity of steam condensed, per unit of surface, in unit time, for one degree difference in temperature of heating steam and liquid being heated, if a is made to represent the mean coefficient of heat transmission, that is, the number of heat units transmitted from the heating steam to the liquid being heated in the body of a multiple effect, per unit of surface, in unit time, for one degree difference in temperature, it follows, according to Déon,* that:

$$D = \frac{a}{A + BT_x - (\theta_x - 32)} \qquad \text{(j)}$$

and, substituting this value of D, and also the values of A and B, formula (i) becomes:

$$Q_x = \frac{F_x a (T_x - \theta_x)}{1081 \cdot 4 + \cdot 305 T_x - (\theta_x - 32)} \qquad \text{(k)}$$

* $A + BT_x$ in Déon's formulæ equals $1081 \cdot 4 + \cdot 305 T_x$, which is the total heat of steam of T_x temperature (Fahr.). He assumed, as we will see later, that the water of condensation of the heating system is reduced to the temperature of the liquid boiling in body, hence, according to this, $A + BT_x - (\theta_x - 32)$ will be the heat given out by each unit quantity of steam condensed, and, since D is the quantity of steam condensed per unit of heating surface, and a is the heat transmitted per unit of heating surface, then $D [A + BT_x - (\theta_x - 32)] = a$.

which is a formula in accordance with Déon's deductions of the same general form as Jelinek's formula (b), and contains the same factors.

From formulæ (b) and (k):

$$F_x = \frac{Q_x(1115{\cdot}2 - {\cdot}708T_x)}{\alpha(T_x - \theta_x)} \tag{l}$$

$$\text{and } F_x = \frac{Q_x[1081{\cdot}4 + {\cdot}305T_x - (\theta_x - 32)]}{\alpha(T_x - \theta_x)} \tag{m}$$

Formulæ (l) and (m) give the heating surface of any body of a multiple effect according to Jelinek and Déon, respectively, when all losses of heat are neglected, and contain only known quantities, since the value of Q_x is readily determined when it is remembered, as above stated, that the vapour of evaporation in any body is the heating steam for the following body.

Let us now apply formulæ (l) and (m) to the calculation of the heating surface of the second body of the double effect under consideration, using first Jelinek's formulæ. If the Roman numeral subwritten to a letter, representing a quantity, indicates the body of the apparatus to which the quantity has reference,* it follows, from the foregoing, that $p_I = Q_{II}$, $p_{II} = Q_{III}$, &c., and by formula (d)

$$p_I (= Q_{II}) = \frac{F_I\alpha(T_I - \theta_I)}{1081{\cdot}4 + {\cdot}305\theta_I - (t_I - 32)}$$

Substituting this value of Q_{II} in value of F_{II}, found by formula (l), and remembering that $(T_I - \theta_I) = (T_{II} - \theta_{II})$, the heating surface of the second body of a multiple effect will then be:

$$F_{II} = \frac{F_I(1115{\cdot}2 - {\cdot}708T_{II})}{1081{\cdot}4 + {\cdot}305\theta_I - (t_I - 32)} \tag{n}$$

and giving to each quantity in this last formula its proper value, we get for the heating surface of the second body of the double effect in question:

$$F_{II} = \frac{2000 \times (1115{\cdot}2 - {\cdot}708 \times 184)}{1081{\cdot}4 + {\cdot}305 \times 184 - 118} = 1932{\cdot}14 \text{ sq. ft.} \tag{l}$$

This is the required heating surface for the second body of the double effect calculated by Jelinek's formulæ.

To make the calculation according to Déon's deductions, formula (m) gives:

$$F_{II} = Q_{II}\frac{[1081{\cdot}4 + 305T_{II} - (\theta_{II} - 32)]}{\alpha(T_{II} - \theta_{II})} \tag{o}$$

and since $p_I = Q_{II}$, and, in the present case, $\theta_I > t_I$, we have, by formula (h), substituting for D its equivalent, given by (j), $\dfrac{\alpha}{1081{\cdot}4 + {\cdot}305T_I - (\theta_I - 32)}$:

$$p_I (= Q_{II}) = \frac{F_I\alpha(T_I - \theta_I)\left[T_I - \dfrac{\theta_I + t_I}{2}\right] - (T_I - \theta_I)(\theta_I - t_I)G_I s_I}{\left[T_I - \dfrac{\theta_I + t_I}{2}\right]\left[1081{\cdot}4 + {\cdot}305\theta_I - s_I(\theta_I - 32)\right]} \tag{p}$$

Substituting this value of Q_{II} in (o), and remembering that $(T_I - \theta_I) = (T_{II} - \theta_{II})$, we then get:

* No. 1 being the body into which the liquid and heating steam first enter.

$$F_{II} = \left\{ \begin{array}{l} \dfrac{F_I\,[1081{\cdot}4 + {\cdot}305T_{II} - (\theta_{II} - 32)]}{1081{\cdot}4 + {\cdot}305\theta_I - s_I(\theta_I - 32)} - \\ \dfrac{G_I s_I(\theta_I - t_I)\,[1081{\cdot}4 + {\cdot}305T_{II} - (\theta_{II} - 32)]}{a\left[T_I - \dfrac{\theta_I + t_I}{2}\right]\left[1081{\cdot}4 + {\cdot}305\theta_I - s_I(\theta_I - 32)\right]} \end{array} \right\} \quad (q)$$

This last formula corresponds with formula (n), derived from Jelinek's formula, but unlike formula (n), it still contains one unknown quantity, G_I, which represents the quantity of original liquid entering the apparatus in unit time. The value of G_I may, however, be determined thus:—

The quantity of water evaporated in the second body of a double effect, in unit time, will be given by formula (h_c), since the temperature of the liquid entering the body is higher than the temperature of boiling,* hence,

$$p_{II} = \left\{ \begin{array}{l} \dfrac{F_{II}a(T_{II} - \theta_{II})\,[1081{\cdot}4 + {\cdot}305T_{II} - (\theta_{II} - 32)] +}{1081{\cdot}4 + {\cdot}305\theta_{II} - s_{II}(\theta_{II} - 32)} \\ \dfrac{(1081{\cdot}4 + {\cdot}305\theta_{II})\,(\theta_I - \theta_{II})\,(G_I - p_I)\,s_{II}}{[1081{\cdot}4 + 305T_{II} - (\theta_{II} - 32)]} \end{array} \right\} \quad (r)$$

and substituting in (r) the value of F_{II} and p_I, found by (q) and (h), giving D its value according to (j), an expression is obtained for the value of p_{II}, in which there is only one quantity unknown, G_I. Adding the value of p_{II}, found by (r), to the value of p_I, found by (h_I), giving D its value according to (j), we obtain the total evaporation of water in the two bodies of the apparatus, and, if B_I represents the Brix of G_I, quantity of original sugar solution entering the apparatus, and B_x represents the Brix of the same solution after concentration, or as it is discharged from the apparatus, then :

$$p_I + p_{II} = G_I\left[1 - \frac{B_I}{B_x}\right] \quad (s)$$

and from this

$$G_I = \frac{p_I + p_{II}}{1 - \dfrac{B_I}{B_x}} \quad (t)$$

Applying this to our calculation we first obtain the value of p_I by giving to each quantity its proper value in formula (h) or (p):

$$p_I = \frac{2000 \times 4 \times 44 \times \left(228 - \dfrac{184 + 150}{2}\right) - 44 \times (184 - 150) \times G_I}{\left(228 - \dfrac{184 + 150}{2}\right) \times \left[1081{\cdot}4 + ({\cdot}305 \times 184) - 152\right]} \quad (2)\dagger$$

$= 357{\cdot}17 - {\cdot}0248G_I$ lbs. per min.

* The temperature of the liquid entering a body is necessarily, in the ordinary construction of a multiple effect, the temperature of boiling in the preceding body, since the liquid flows directly from one body to the other. The quantity of liquid entering a body is equal to the quantity of juice entering the preceding body, minus the water evaporated in latter body. D has been replaced by its equivalent, $\dfrac{a}{1081{\cdot}4 + {\cdot}305T_{II} - (\theta_{II} - 32)}$.

† A value of 4 per min. for a is about the average for the ordinary standard vertical multiple effect when clean. The value given to a will not, however, affect the comparative results obtained by the different formulæ in the present calculations, provided it remains constant.

The value of s_x in this case is taken as 1 (which is the specific heat of water at 32° Fahr.), since in Jelinek's formula the specific heat of liquid is considered to be 1.

formula (h_c) or (r) gives the value of p_{II}:

$$p_{II} = \left\{ \frac{F_{II} \times 4 \times 44 \times (1081{\cdot}4 + {\cdot}305 \times 184 - 108) + }{(1081{\cdot}4 + {\cdot}305 \times 140 - 108)} \atop \frac{(1081{\cdot}4 + {\cdot}305 \times 140)\ (184 - 140)\ (G_I - p_I)}{(1081{\cdot}4 + {\cdot}305 \times 184 - 108)} \right\} \quad (3)$$

$$= {\cdot}173 F_{II} + {\cdot}046 (G_I - p_I) \text{ lbs. per min.}$$

and from (q) gives the value of F_{II}:

$$F_{II} = \left\{ \frac{\dfrac{2000 \times (1081{\cdot}4 + {\cdot}305 \times 184 - 108)}{1081{\cdot}4 + {\cdot}305 \times 184 - 152} - G_I (184 - 150)\ (1081{\cdot}4 + {\cdot}305 \times 184 - 108)}{4 \times \left(228 - \dfrac{184 + 150}{2}\right) (1081{\cdot}4 + {\cdot}305 \times 184 - 152)} \right\} \quad (4)$$

$$= 2089{\cdot}29 - {\cdot}1455 G_I \text{ sq. ft.}$$

Substituting in (3) this value of F_{II}, and the value of p_I from (2) gives:—

$$p_{II} = {\cdot}173 (2089{\cdot}29 - {\cdot}1455 G_I) + {\cdot}046 [G_I - (357{\cdot}17 - {\cdot}0248 G_I)] \quad (5)$$
$$= 345{\cdot}02 - {\cdot}022 G_I \text{ lbs. per min.}$$

Now by formula (t)

$$G_I = \frac{(357{\cdot}17 - {\cdot}0248 G_I) + (345{\cdot}02 - {\cdot}022 G_I)}{1 - \dfrac{12}{54{\cdot}3}} = 898{\cdot}06 \quad (6)$$

which substituted in (4) gives:—

$$F_{II} = 2089{\cdot}29 - {\cdot}1455 \times 898{\cdot}06 = 1958{\cdot}62 \text{ sq. ft.}$$

This is the required heating surface for the second body of the double effect found by using Déon's formulæ.

The second information desired, in the order of inquiry, is the total quantity of sugar solution the double effect is capable of concentrating from 12° to 54·3° Brix under the conditions stated. This is given, according to Déon's formula, by (6), and equals 898·06 lbs. per min.

To find the capacity of the apparatus according to Jelinek's formulæ, we must first determine the evaporation in each body by formula (d), and then substitute these values in formula (t). Giving the proper values to the quantities in (d) we get:—

$$p_I = \frac{2000 \times 4 \times 44}{1081{\cdot}4 + ({\cdot}305 \times 184) - 118} = 345{\cdot}26 \text{ lbs. per min.} \quad (7)$$

and, taking the value of F_{II} given by (1):

$$p_{II} = \frac{1932{\cdot}14 \times 4 \times 44}{1081{\cdot}4 + {\cdot}305 \times 140 - 152} = 349{\cdot}81 \text{ lbs. per min.} \quad (8)$$

Substituting these values of p_I and p_{II} in (t):

$$G_I = \frac{345{\cdot}26 + 349{\cdot}81}{1 - \dfrac{12}{54{\cdot}3}} = 892{\cdot}15 \text{ lbs. per min.} \quad (9)$$

which is the total quantity of sugar solution the double effect is capable of concentrating from 12° to 54·3° Brix, as calculated by Jelinek's formulæ.

The evaporation of water in each body of the double effect, according to Déon's formulæ, is determined by substituting the value of G_{I}, given by (6), in (2) and (5):

$$p_{I} = 357{\cdot}17 - {\cdot}0248 \times 898{\cdot}06 = 334{\cdot}90 \text{ lbs. per min.}$$
$$p_{II} = 345{\cdot}02 - {\cdot}022 \times 898{\cdot}06 = 364{\cdot}78 \quad ,,$$

Finally, as regards the steam required to operate the double effect, Jelinek's formula, (b), gives:

$$Q_{I} = \frac{2000 \times 4 \times 44}{1115{\cdot}2 - {\cdot}708 \times 228} = 369{\cdot}06 \text{ lbs. per min.}$$

and formula (k), derived from Déon's formulæ, gives:

$$Q_{I} = \frac{2000 \times 4 \times 44}{1081{\cdot}4 + {\cdot}305 \times 228 - 152} = 352{\cdot}37 \text{ lbs. per min.}$$

The results obtained, as calculated by Jelinek's and Déon's formulæ, and tabulated for convenience of comparison, are:—

Calculations for a Double Effect. Steam, $5\frac{3}{4}$ lbs. Juice, 150° F. Vac. Cor. to 140° F.	According to Jelinek.	According to Déon.
Heating surface of first body, sq. ft.	2000·00 ..	2000·00
,, ,, second ,, ,, ...	1932·14 ..	1958·62
Solution concentrated, 12° to 54·3° Brix, lbs. per min.	892·15 ..	898·06
Water evaporated in first body, lbs. per min.....	345·26 ..	334·90
,, ,, second ,, ,, ..	349·81 ..	364·78
Steam required to operate apparatus ,, ...	369·06 ..	352·37

On comparing the above figures it will be seen that the results of calculations by Jelinek's formulæ are generally larger than those obtained by Déon's formulæ, and that the differences in the present case are considerable.

(To be continued.)

CHEMICAL CONTROL UNDER THE BONDING SYSTEM.

By Prof. Dr. A. Herzfeld.

As is well known, the Brussels Convention requires, in Art. 2, that all the contracting States shall introduce a system of controlling in bond the output not only of the new sugar factories, but also of the refineries and molasses factories. This system (also called the warehousing system) is officially described as a continuous supervision on the part of the customs authorities of the work in the different departments of the factory, and a close estimation of the amount of sugar turned out.

The raw sugar factories, now placed under control in all their departments, must be so arranged that the surreptitious abstraction of sugar is an impossibility, and the finished product must be stored in sheds which ensure the necessary conditions being carried out. The sugar going out for home consumption will be subjected to an excise duty, that for export will be simply deducted from the total output.

The official definition of the bonding system is not exhaustive enough to prevent the acquiring by single countries or factories of a bounty, as one or two simple illustrations will easily show.

For example, let us suppose that England retains her present system of valuation of the sugar according to its polarisation, and may possibly increase her present rates of duty.

The sugar going into the refineries gives, as every chemist is aware, different profits, according to its purity and content in invert sugar. The refinery can furthermore obtain different kinds of runnings according as it turns out table syrup more or less rich in invert sugar. The bare control of the factory manufacture by day and night, as well as the accurate weighing of the products sent out will never suffice as a criterion of actual output. If only because of the turning out of liquid products as syrups, which moreover may vary considerably in water content, such a system is useless.

For a bonding system to be in any measure practical, it appears in theory quite necessary at the very least to ascertain the quality of the sugars entering the factory as regards their purity and sugar content.

A uniformly just mode of treatment of the sugar for consumption in the different countries can be ensured in two ways.

The first way consists in arranging that only untaxed sugar enters a refinery. Then all the sugar which goes into consumption, will be liable to an excise duty, which on the one hand is based on its absolute content in sugar, invert sugar, and glucose, and on the other on the proportion of sugar *plus* invert sugar or glucose to non-sugar. The limits of freedom from duty of the syrups for lower comsumptive purposes must be one and the same everywhere. Every deviation in the valuation of similar products in the different countries must be looked on as a favouritism, or a bounty to the refineries of those lands which place a lower tax on the particular product in proportion to its content and purity, unless every kind of surtax be renounced.

The second way consists in levying excise or customs duties on the sugar entering a refinery according to its estimated yield, in which case the control is solely concerned in ensuring that no untaxed sugar finds its way into the refinery.

This system has always had a special attraction for the financial authorities of the participating States, because it appears suited for considerably simplifying the control, and has been adopted also by the chemists, as lending to their knowledge a rôle of importance. It need not then be wondered that in practice several experiments on these lines have been undertaken.

Till the year 1864 sugar in general was classified under this system according to colour, almost entirely by the employment of the known 20 Dutch standards.

In the year 1864-65 at the Cologne refinery of the Rhinish Company experiments were undertaken by England, France, Holland, Belgium,

and the German customs union to establish the profit ensuing from refining sugars of different colours and the specific results were as follows:—

	Gave Per cent. Loaf Sugar.
1. Sugar of No. 7 D.S.	67
2. ,, ,, 7, 8 and 9 D.S...	80
3. ,, ,, 10-14 D.S.	88
4. ,, ,, 15-18 D.S.	94

On the strength of these experiments a Convention was concluded between the participating States, on November 28, 1864, in which they mutually undertook to arrange their scale of duties in accordance with the Cologne experimental results. The yield in loaf sugar and similar sugar, such as granulated, was to serve as a standard and the above mentioned four classes were to be arranged as a basis of taxation.

Under the circumstances, the refiners only worked up sugar of such a colour which by suitable admixture could be artificially increased, so that much higher yields were obtained; for example, from sugar of No. 7, D.S., 88% was actually secured, instead of the official 67%.

The result was that France in spite of the protests of the remaining powers, instead of the four classes-system, arranged only two classes for raw sugar, viz., of 1-12 and 13 to 20 Dutch Standard. A diplomatic quarrel followed, which ended in fixing 30th June, 1871, as the last date for the regulation of the matter. But the war of 1870 intervened, and made an end of both the negotiations and of the convention.

In the meantime the uselessness of the Dutch colour system had become apparent: Holland itself used polarisation instruments from 1872 for the customs control, and the Union of the Beet Sugar Industry offered a prize in 1871 for a process to estimate the refining value of raw sugar, and this prize was awarded in the following year to Scheibler for a washing process for crystals in the raw sugar.

A process similar to the Scheibler one was introduced into Holland, but could not penetrate into Germany, although several official experiments undertaken for that purpose, and for which a special experimental factory was fitted out, gave alleged favourable results. Later on von Lippmann showed, that in this case clearly unreliable conclusions were offered, inasmuch as the Commission nominated by the State to investigate the process had not worked up their own afterproducts into refined, but had estimated the yield for these products by the Scheibler method itself, the very one it was required to test. Nowadays we know that it is utterly impossible to obtain accurate output figures by this Scheibler process, as the liquids used in the process may produce on the one hand, either a sugar in

precipitation, or in solution and on the other hand, this washing experiment is only possible under conditions of an even temperature, a point that was overlooked in the Scheibler experiments. Finally, the washed crystals are not yet refined, and the test does not show how much will be got out of them eventually.

The washing out process has consequently not been extended any further. It also appears impossible that it will ever do, because the bare content in sugar crystals in the raw sugar, or the polarisation of these crystals, as we nowadays well know, can never form an accurate standard for the refinery output; this latter depends before all things on the purity of the crystals, which is subject to big fluctuations.

In this connection, individual States have made experiments for undertaking the valuation of the sugar by the so called *trade yield* In France, a system is still in force in which the refinery value of the sugar introduced is put down according to the yield, which latter is calculated by substracting the ash four times, and the glucose twice, from the polarisation, with an allowance of $1\frac{1}{2}\%$ for manufacturing losses; the half yearly audit checks the figures to ensure that the actually exported amounts of refined sugar shall correspond to the booked figures of output. In case of an overplus, the same is taken into account afterwards.

Apart from the fact that this particular method of calculating the yield is wanting in a scientific basis, it is clear that a test of that kind gives no accurate measure of the output so soon as the refinery produces a fixed sugar of essentially different purity or even in a liquid condition. The second method available, that of ascertaining the value of the raw material and the output obtainable therefrom is entirely defective in practise, for it can never in the present state of science lead to a satisfactory bonding system.

Consequently the first way is the only suitable one, but it can only continue to exist if chemical analysis comes to its aid, so as to classify the similar products of refining under their real value, and if the rates of duty are everywhere, and as much as possible, arranged in accordance with these valuations.

It ought to be within the scope of the International Commission to exercise its influence on the rules which bear on the valuation of individual merchandise.

In fact there is great want of a good method, but the conclusive solution of the task is opposed by great difficulties.

For the present it will suffice if the attention of the members of the Commission is drawn to this point; the rest we can leave to the future, when no doubt we shall have to go more fully into this question.—*(Vereinszeitschrift.)*

THE WORKING EFFICIENCY OF WATER-DRIVEN CENTRIFUGALS.

At the request of Messrs. Watson, Laidlaw & Co., the well-known makers of Centrifugal Machines, Professor W. H. Watkinson, of Glasgow, recently undertook to test the efficiency of a battery of that firm's water-driven centrifugals. The Professor's subsequent report is of considerable interest and having been favoured with a copy of the same, we are enabled to place it before our readers. It is necessary to point out that the pump used for the tests was the firm's regular shop service pump for testing machines before shipment, and was not made specially for the purpose of the test. As a matter of fact it is much larger than would be supplied for a set of three 30 in. machines, and, therefore, the efficiency of the pump does not show so high as it would have done had it been of the proper size:—

Engineering Laboratory, 38, Bath Street,
Glasgow, 30th June, 1903.

Messrs. WATSON, LAIDLAW & Co., Glasgow.

Dear Sirs,—In accordance with your request I tested a battery of Water-driven Centrifugals at your works on the 12th of June, 1903, and beg to report as follows:—

The battery tested consisted of three water-driven "Weston" Centrifugals having baskets 30 in. diameter by 18 in. deep.

The water for driving the centrifugals was supplied by a Duplex Steam Pump, having steam cylinders 16 in. diameter and pumps 8 in. diameter with a stroke of 10 in.

The Pump was connected to the battery by a pipe 3 in. bore by 17 ft. long, having two bends. This is exclusive of the main pipe on the battery with the small distributing pipes to each centrifugal.

Indicator Diagrams were taken from each end of both steam cylinders simultaneously, and the water discharged was weighed.

The cycle of operations was taken at six minutes, that is:—

Two minutes for acceleration to full speed.
,, ,, ,, maintaining at full speed.
,, ,, ,, stopping and emptying.

Each machine was fitted with two water valves having nozzles respectively 0·375 in. bore and 0·203 in. bore.

The basket contained a load of 295 lbs. consisting of wooden boxes filled with iron borings.

With a water pressure of 150 lbs. per square inch, the centrifugal was accelerated, in two minutes, to a speed of 1,247 revolutions per minute, the consumption of water being 550 lbs. per minute.

With a water pressure of 150 lbs. per square inch, the centrifugal was maintained for two minutes at a speed of 1,247 revolutions per minute, the consumption of water being 127 lbs. per minute.

With a water pressure of 150 lbs. per square inch, one centrifugal accelerating and one maintaining full speed at the same time, the consumption of water was 674 lbs. per minute.

From the data obtained the following calculations were made :—

Indicated horse-power during acceleration	6·69
,, ,, ,, maintaining	1·76
,, ,, ,, full stop	0·118
	3) 8·568
Average indicated horse-power for the cycle	2·856
Water horse-power during acceleration	5·78
,, ,, ,, maintaining	1·34
,, ,, ,, full stop	0·00
	3) 7·12
Average water horse-power for the cycle	2·37

When one centrifugal was being accelerated and one was being maintained at full speed :—

The indicated horse-power was	8·19
The water horse-power was	7·10

From the above we see that the total loss of efficiency caused by leakage, internal friction in the pumps and steam cylinders, the loss in the valves, pipes, &c., was as follows :—

When accelerating one centrifugal and maintaining one centrifugal at full speed, loss of efficiency .. .. .. $\left(1 - \frac{7\cdot1}{8\cdot19}\right) \times 100 = 13\cdot3\%$

When accelerating one centrifugal only $\left(1 - \frac{5\cdot78}{6\cdot69}\right) \times 100 = 13\cdot6\%$

When maintaining one centrifugal only $\left(1 - \frac{1\cdot34}{1\cdot76}\right) \times 100 = 23\cdot8\%$

The small loss of efficiency with this system under average conditions is due mainly to the fact that the speed of the engine and pump automatically varies in accordance with the demand for power by the centrifugals. With all other systems the steam engine and dynamos, or belt gearing, &c., run at a constant speed whether the demand for power by the centrifugals be great or small, and, in consequence, the frictional and other losses with these is much greater throughout the cycle than with your hydraulic system of driving.

Yours faithfully,

(Signed) W. H. Watkinson.

THE CARBONACEOUS MATTER OF ANIMAL CHARCOAL.*

BY T. L. PATTERSON, F.I.C., F.C.S.

Introductory.—Animal charcoal is the final product of the destructive distillation of bones. Care is taken in its manufacture not to raise the temperature above a moderate red heat, otherwise the earthy constituents will be partially fused or fritted, with more or less destruction of its porosity and reduction of its valuable decolorising property. On the other hand the temperature must be high enough and long enough maintained, to sufficiently carbonise the bones and drive off the volatile products, which consist of hydrocarbon gases, water containing ammonia, cyanides, &c., and a tarry oil containing volatile organic bases and hydrocarbons.

The so-called carbon is the chief constituent of animal charcoal on which its decolorising power depends; but the mineral or earthy constituents are almost equally important, for they not only assist in absorbing earthy salts, they form a porous framework on which the active constituent is deposited and give the whole a hardness which makes it easily handled and reburned with little loss of carbonaceous matter. The carbon in animal charcoal is not pure carbon, but consists of a series of complex organic bodies containing a large percentage of nitrogen. The charcoal from wood is much purer carbon than that from bones, but it has little or no decolorising power and contains little or no nitrogen. Hence it has long been considered essential that charcoal for decolorising purposes should be nitrogenous. The combination in which nitrogen exists in animal charcoal has not hitherto been investigated. One of the objects of this inquiry was an examination of this subject.

In a note to the *Chemical News* (1873, **27**, 111), I made the statement that "Animal charcoal when new and of good quality contains about 4·5 per cent. of organic matter. A small portion is soluble in water, the greater part is soluble in acid, and the remainder is insoluble in either menstruum. When charcoal is ignited the loss of weight is equal to the carbon + organic matter + water." This statement requires some modification, it was controverted at the time by some chemists who would not believe that bones which had been submitted to a red heat for a lengthened period could contain any organic matter. But its presence, which was known before, is now generally admitted. It was my intention to return to this subject and study more closely the loss which charcoal undergoes on ignition, but circumstances prevented me doing so until now. When it is remembered that bones are never completely carbonised and are still giving off volatile vapours when raked from the retorts into air-tight receivers, the existence of more or less organic matter in the finished charcoal is not to be wondered at.

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* From the Journ. Soc. Chem. Industry, Scottish Section.

Its presence is easily demonstrated by dropping a small portion of charcoal into concentrated sulphuric acid in a test tube. The acid assumes a more or less brown colour in proportion to the organic matter present, good new charcoal giving a dark brown colour, whilst spent charcoal gives little or none. The colour is not due to the destructive action of the acid on the organic matter, as is the case when many organic substances are digested with sulphuric acid. I am of the opinion that the brown organic matter exists in the charcoal as such, and gives the charcoal itself a more or less brownish black colour in proportion to the quantity present. It is partially soluble in cold sulphuric acid without decomposition and the portion dissolved may be completely recovered by precipitation with water. I have taken advantage of this reaction to separate a portion of the organic matter insoluble in hydrochloric acid.

When animal charcoal is heated it loses weight, and it continues to lose weight when heated up to 300° C. and over, without visibly suffering oxidation or decomposition. Chemists differ in opinion regarding this loss. Some hold that it is due to moisture not expelled at the temperature of the water oven and have recorded experiments in support of this contention. The late Dr. Wallace, who was an authority on charcoal, from experiments recorded in the *Sugar Cane* (1869, 1, 115) arrived at the conclusion that it is necessary to dry new charcoal at a temperature of 350° F.—about 160° C.—for 10 minutes to drive off all the water. Wilson (*Chem. News*, 1873, **27,** 225) heated animal charcoal to 500° F.—about 260° C.—and recorded the loss as water. On the other hand many chemists consider these temperatures too high and estimate water at lower temperatures. The opinion, however, is general that a greater heat than 100° C. is necessary to expel the water from new charcoal, but no temperature has been fixed for this purpose and consequently we have the water estimations recorded at various temperatures over 100° C. I agree with the opinion that moisture or uncombined water is not completely eliminated at 100° C., but I have always adhered to this temperature, or rather to the temperature of the water oven, which is only 95° C. or 96° C. One reason for this is because of the difficulty of fixing a temperature over 100° C. when hygroscopic water ceases to be given off and organic bodies begin to be broken up. Another is because the carbonaceous residue from hydrochloric acid is always dried and weighed at 100° C., although, like charcoal itself, all the water is not completely expelled at that temperature. By drying charcoal at temperatures over 100° C. and carbonaceous matter at 100° C. only, the organic matter soluble in hydrochloric acid, which is a different quantity, is returned too low. Decomposition of the organic bodies takes place at comparatively low temperatures, and water is one of the products, as I shall have occasion to point out later, hence water determinations made at temperatures considerably over 100° C. will record such water as well as mere moisture.

Loss of Carbonic Acid in Igniting Charcoal.—The problem which I set myself to investigate is this—apart from water lost in the water-oven, of what does the portion burnt off consist? I have said, in the statement above referred to, that it consisted of a little organic matter soluble in water, a much larger portion soluble in hydrochloric acid and carbon plus the remaining organic matter insoluble in either menstruum. This statement requires to be considerably modified, so far as the portion soluble in hydrochloric acid is concerned. I now find that the greater portion is insoluble in hydrochloric acid and closely united with the carbon, and that the loss on ignition, apart from carbonaceous matter, which has hitherto been set down as soluble organic matter, is chiefly carbonic acid liberated from the ash in the process of ignition, with perhaps a little water not recovered at 100° C. It was only in the course of this investigation that I suspected the loss of carbonic acid on ignition. The reason why it has been overlooked hitherto is because the carbonate of lime in charcoal is always calculated from the weight or volume of carbonic acid liberated from the unburned charcoal. When carbonic acid is at the same time determined with the ash the loss is revealed.

The loss of carbonic acid is due to the decomposition of carbonate of lime by the phosphate of lime in the presence of carbon; no lime is set free. In the analyses I have made, to be considered shortly, the ashes, in every case after weighing, were treated with carbonate of ammonia to carbonate any free lime, slightly ignited and again weighed. The weight remained constant except in two or three cases, where it was only increased by 0·2 mgrm. The phosphate of lime in charcoal combines easily with the lime in the carbonate of lime at a low red heat to form a more basic phosphate than tri-basic phosphate, which is only decomposed by the stronger acids. As charcoal becomes old with use the carbonate of lime disappears. This loss has been explained by assuming that the organic acids in the sugar liquor passed over it were neutralised by the carbonate of lime. As a matter of fact, very little carbonate of lime is removed in this way, the organic acids not being powerful enough to decompose it, except in the weak liquors when washing off. The repeated burning to which the charcoal is exposed in the process of revivification is responsible for this gradual decomposition of carbonate of lime with formation of basic phosphate. So that charcoal which contained when new 6 to 8 per cent. of carbonate of lime, may not contain more than $\frac{1}{4}$ per cent. when spent. But the phosphoric acid is in combination with nearly as much lime as the carbonate of lime and phosphate of lime together contained when it was new. This is a subject which I investigated many years ago. It was very fully discussed by Frazer Smith in a paper communicated to the *Chemical News* (Vol. 33, p. 100, 1876), to which those interested in the subject may be referred. My present experiments show that the mere ignition of charcoal to burn

off carbonaceous matter determines the same decomposition of carbonate of lime as is only brought about in the refinery in the course of two or three years' reburning. In the analyses recorded now it will be observed that as much as 3 per cent. of carbonic acid is liberated in the process of igniting new charcoal over a Bunsen lamp. Doubtless the carbonaceous matter assists by reducing the carbonic acid to carbonic oxide. Hence the organic matter soluble in hydrochloric acid, which I have hitherto supposed to exist in new charcoal, will be reduced by this amount.

Separation and Estimation of Organic Matter.—I have said that a portion of the organic matter insoluble in hydrocholoric acid is soluble in sulphuric acid, from which it may be recovered. The separation is carried out in the following manner: The carbonaceous matter + organic matter and sand, from about 1 grm. of charcoal, which remains on a tared filter after treatment with hydrochloric acid and washing, is dried and weighed. As much as can be easily removed from the filter is transferred to a small dry beaker. The filter and adhering carbonaceous matter are dried and again weighed. The carbonaceous matter in the beaker is covered with about 10 c.c. of concentrated sulphuric acid, stirred and set aside with occasional stirring. When the carbonaceous matter is dry, no heat is developed and no decomposition takes place. After a couple of hours, when the acid has taken up all that it will dissolve, the contents of the beaker are poured on a dry asbestos filter, and the acid sucked through with the pump. The beaker is rinsed with a few cubic centimetres of sulphuric acid, and added to the carbonaceous matter on the filter; when that is sucked through the separation is completed by washing, first with a few cubic centimetres of sulphuric acid, and finally with a weaker acid of 1·750 sp. gr., until the acid comes through colourless. The carbonaceous matter on the filter is reserved for further treatment.

The sulphuric acid filtrate, which has a deep brown colour in proportion to the organic matter dissolved, is now poured into a large volume of water, about 10—12 times the volume of the filtrate, and the acid residue in the receiver washed in with water. On stirring and setting aside for some hours or over-night, nearly the whole of the organic matter settles to the bottom as a deep brown flocculent precipitate, which can be collected on a tared filter, washed with boiling water, dried, and weighed. A very small quantity remained dissolved in the acid filtrate, which is not separated by neutralising the acid, but it can be completely recovered by passing the dilute filtrate through the carbonaceous matter from which it was separated, or through a separate weighed portion of carbonaceous matter and its weight ascertained directly, after the carbonaceous matter has been washed and dried on a tared filter. The organic matter is very gelatinous, and filters with difficulty, even with the pump. But it need not be directly estimated, since its weight can be ascertained

from the difference in weight of the carbonaceous matter before and after separation. Only one or two direct estimations were made, to make sure that the organic matter thus recovered accounted for the loss in weight of the carbonaceous matter treated with sulphuric acid. It will be seen that this was the case from the analysis of the carbonaceous matter insoluble in hydrochloric acid which is given below.

Returning to the residue on the filter, the acid-washed carbonaceous matter, asbestos and grid are transferred to a large beaker and the funnel washed into it with water. The grid is lifted out and the asbestos and adhering carbonaceous matter washed off with water. The beaker is half-filtered with hot water, which is then boiled and allowed to settle, the liquid decanted through a tared filter, and the residue similarly treated five or six times, with boiling in each case before decantation, since very careful washing is necessary to completely free the asbestos from sulphuric acid. When thoroughly washed it is dried in the water oven and weighed. The filter and its contents are then ignited and weighed again. The loss on ignition after making corrections for the asbestos, sand, and the portion adhering to the first filter is carbonaceous matter thus found and the carbonaceous matter + organic matter weighed on the first filter corrected for the sand, which has been estimated in another portion of the charcoal, gives the organic matter soluble in sulphuric acid.

The filter for the acid separation is best made by forming a mat of asbestos on the surface of the small porcelain grid supported in a small funnel. Asbestos suspended in water, which has been previously washed, and cut into short lengths, is poured on to the grid until it is evenly covered, and the water filters through clear, when it is dried in the water oven. Some little experience is required in making these filters, for if the mat be too thick filtration is very slow; if not thick enough the filter is easily burst. Since asbestos contains water of crystallisation, and even ignited asbestos when moistened does not give up all its water at 100° C. a factor has to be found by which the weight of the ignited asbestos is increased to give its weight at 100° C. A portion of the asbestos used to make the filters is dried at 100° C. and weighed. It is then ignited and weighed again. The former weight divided by the latter gives the factor. As two portions of asbestos are not by any means uniform in the loss they sustain on ignition, slight inaccuracies may occur in the corrections for this substance, but the results may be taken as quite sufficiently accurate for all practical purposes.

The organic matter separated by sulphuric acid is only a portion of that contained in the carbonaceous residue from hydrochloric acid. I am inclined to believe that a much larger portion remains undissolved. As evidence of the non-elementary nature of this residue, I may say that a further quantity of organic matter may be separated by digesting

the portion insoluble in cold sulphuric acid, with sulphuric acid heated to 100° C. in the water-bath for an hour or two. Nordhausen acid also dissolves organic matter from the same residue without apparent decomposition, from which it can afterwards be separated by filtration through asbestos, diluting the filtrate with sulphuric acid and pouring the mixture into water.

When this same residue, from which all the organic matter soluble in cold sulphuric acid has been separated, is heated to boiling with sulphuric acid for a few minutes, cooled and filtered, another portion of organic matter is separated. When the acid filtrate is thrown into water a brown precipitate falls out as before. This experiment was repeated a third time with the carbonaceous residue filtered from the boiling sulphuric acid with the same result. The only difference between these two portions of organic matter and the first is that the precipitate is somewhat darker, denser, and settles more easily, and that in the order in which the experiments were made. I did not pursue the inquiry further in this direction, but have no doubt that other boilings would have dissolved more of the organic matter, and as sulphuric acid was liberated from the boiling acid on each occasion, and other signs of decomposition were evident, I did not consider it worth determining the amount of organic matter separated in relation to the carbonaceous matter.

Colour-absorbing Property of the Organic Matter.—The observation that the supernatant acid liquid in the two last experiments was colourless when the precipitate settled gave rise to the suspicion that the brown organic matter might be able to absorb colouring matters from solution, and that it might really be part of the active constituent of the carbonaceous matter. To put this supposition to the test, the supernatant liquid was poured off, and the residue from each, together with the brown organic matter, transferred to a 100 c.c. flask. 1 c.c. of a standard caramel solution was added, and each flask made up to the mark with water and transferred to a bottle for observation. At the same time 1 c.c. of standard caramel solution was made up to 100 c.c. with water and transferred to another bottle. After a few days, when the organic matter had completely settled, the solutions were filtered, and the colours compared with that of the standard solution. The mean of two closely-agreeing experiments gave 33·3 per cent. of colour absorbed by the organic matter separated by the first boiling with sulphuric acid, and 42·4 per cent. for the organic matter separated by the second boiling; and the amount of the organic matter filtered and weighed on a tared filter was 0·0198 grm. for the first and 0·010 grm. for the second. Thus the organic matters are shown to be decolorisers, and the second portion, which was the most difficultly soluble in sulphuric acid, a better decoloriser than the first in the proportion of 2·52 to 1. Compared with good charcoal, 1 grm. of which will absorb the colour from 1·048 c.c. of

the standard caramel solution employed, the first portion of organic matter was 16·03 times better, and the second portion 40·46 times better, as a decoloriser.

Having found that the organic bodies separated by boiling sulphuric acid are capable of decolorising a caramel solution, it became necessary to ascertain whether the body separated by cold sulphuric acid possessed the same property. Without detailing the experiment, which was carried out like the others, I may say that 1 grm. of this organic body was found to be capable of absorbing the colour from 17·43 c.c. of caramel solution, which makes it 16·63 times better as a decoloriser than good charcoal. The result is practically the same as that for the first portion separated by boiling sulphuric acid. A similar experiment was at the same time made with the dried organic body separated by cold sulphuric acid, which I assume to be in the same condition as it exists in animal charcoal. 0·0592 grm. of a ground portion was shaken up with the caramel solution employed in the other experiments; after filtering and comparing the filtrate with the standard, it was found to have absorbed colour in the proportion of 0·903 to 1 of standard charcoal. That is to say, it is not quite equal to standard charcoal in decolorising power. I did not try dried portions of the bodies separated with boiling sulphuric acid, but I have no reason to believe that they will show a materially different result. That this should be the case is not surprising, since we know that the bodies soluble in sulphuric acid are not so highly carbonised as those which are insoluble; but when dry these bodies may not be in the same condition as they existed in the original charcoal, although I have assumed that they are, because when a dried portion is redissolved in sulphuric acid, and again precipitated with water, the small portion which remains in solution has a reddish colour, whereas it is yellow on the first solution and precipitation. The property which the precipitated bodies possess of absorbing so easily the colour from a caramel solution, as compared with the same body in the dry condition, must be largely a physico-chemical one. They are extremely finely divided, very gelatinous, and in loose combination with many times their weight of water, so that when brought into intimate contact with coloring matter they absorb it very much as gelatinous alumina absorbs colour from solution to form a lake. The experiments just detailed were carried out on very small portions of the bodies, but they are sufficient to indicate that we are dealing with constituent parts of the carbonaceous matter.

(To be continued.)

Dr. D. Morris, C.M.G., Imperial Commissioner of Agriculture for the West Indies, has been recently appointed a K.C.M.G. in recognition, no doubt, of his meritorious services in the cause of agriculture in the West Indies.

ZUCKERPRODUKTION UND ZUCKERPRAEMIEN BIS ZUR BRUESSLER KONVENTION 1902.

Von Max Schippel.

The above is the title of a book published this year in order to give those interested a clear idea of the present position of the sugar trade in the world, and of the causes and conditions in the past that have led thereto. It displays all the virtues of the German mind and methods and but few of their besetting sins, being clearly written and free from prolixity. The introductory chapter gives a succinct account of the history of sugar from its earliest mention in recorded history, to the end of the eighteenth century, and is so closely stated that further condensation would be difficult. Perhaps the most interesting detail in this portion of the book is the sketch of the rise, decline and fall of cane growing in southern Europe, and the account of the "slump" in sugar and fall in prices that took place at the end of the fifteenth century, and the beginning of the sixteenth. "Already at the end of the middle ages we find for the first time and as a temporary phenomenon, conditions that in modern times have almost become constant; an over-production of sugar that far outstrips the then, not by any means excessive power of absorption of the market. Prices fell with astounding rapidity, and only the strongest producers survived. Sicily, whence Madeira had obtained its first instructors and the plant itself, suffered heavily, 'for the sugar from the Canaries was sold there cheaper than the Sicilian product.' (page 21.) Then followed in rapid succession the rise of the American fields of production. In the early years of the seventeenth century Portugal put a tax on Brazilian sugar to protect the Canaries, though after the loss of India she worked her Brazilian colonies to the full and "in the eighteenth century Portugal for a time provided all Europe with Brazilian sugar." Salvation came with the introduction of slavery and the new beverages, tea, coffee, and cocoa, which increased the consumption of sugar.

No less interesting is the account of the beginning of refining that was first attempted at Antwerp in 1500. Colbert in France stoutly protected the new industry by forbidding it in the French colonies. Even Venice used refining as a substitute for the trade she was losing so fast. In England also sugar refining flourished exceedingly, the chief refining centres deriving their raw material from the Colonies, and rapidly outstripping the home demand, exported largely to the Continent.

In Germany, Hamburg, the Brandenburg districts, and later Prussia, all strove with varying success to establish this method of making money. But Holland came an easy first in the race.

In the second chapter the real subject matter of the book is taken up, and a detailed account of the origin and rise of beet sugar and its export bounties given. As so often happens, the immediate father of this new development reaped a plentiful harvest of disappointment and failure, leaving it to others to gather success after his death. As also not infrequently happens, success did not come first to the inventor's compatriots. Andreas Sigismund Margraf and his pupil Achard were North Germans, and beet sugar was first successful in France, and restarted later in Germany. In both countries it was protected and taxed. But whereas in Germany it was at first violently opposed by the refining interest, in France it was nursed from the beginning. The careful account of the fiscal system that grew out of this new source of sugar is interesting, and even those who have studied the question might do worse than peruse these lucidly written pages. The difficulties of finding a standard were increased by the constant evolution of the beet from a sugar containing root to a sugar making root, the present sugar beet being as completely an artificial product of man's observation and selection as the English race horse or the short-horn breed of cattle. Alternations of too low and too high standards of assessment, of export rebates that were bare returns for the fiscal tax, and were outrageous export bounties, mark the fiscal history of beet in every country in Europe.

In France not only was beet sugar taxed for revenue, but also with a view to keeping the balance between its production and that of the colonies between them, these two sources of production were to divide the consuming power of France fairly. Not till late in the nineteenth century did export enter into French calculations, and as even now France is still dependent on her colonies for part of her raw sugar, her position in regard to the whole question differs from that of Germany and other beet countries. Max Schippel's account of the German bounties concludes with the following instructive sentences, "German sugar then stood (1897) on the American market with bounties exactly as without them; without a bounty it would simply have paid the normal duty, but as it was subsidised to the extent of 2·40 marks per double centner—(2 cwt. approx.) the American Customs saddled it with 2·40 marks per double centner in addition to the normal duty—what benefit accrued then from the bounty?"

"But the American Customs pocketed the 2·40 marks, and the German Chancellery was placed in a thoroughly silly and contra dictory position. The considerable sums it was quite uselessly spending to send sugar to America, left it to pass to the last farthing as a subsidiary benefit to the Washington Treasury." (p. 185.)

Need we wonder that after this was made clear to our continental neighbours, conferences as to the best way to abolish bounties became reasonable possibilities.

After careful study of this very unbiassed account of the history of sugar bounties, no unprejudiced reader can doubt that the system is ready to fall to pieces by the weight of its inherent fallacies, and that the action of Great Britain, which, Schippel allows hastened matters, was inevitable, and it is to be hoped for the interest of the consumer in all countries that the fiscal reform will come in time to save the West Indies. Our German author seems to have his doubts as to this, but being a clear sighted man, it is evident that he is not anxious to see any source of production killed. Cheap sugar is only possible—such is the logical deduction from this impartial history, untainted by any expression of personal opinion—cheap sugar is only possible if both cane and beet are allowed free play, and the natural advantages of both are allowed to have their full effect on the various markets of the world.

E. Robertson.

CONSULAR REPORTS.

Réunion.

The amount of sugar exported during 1902 amounted to 28,955 tons, and all went to France. The figures for the preceding year were 40,887.

United States.

New York.—Sugar to the value of £8,084,000 was imported during 1902 as compared with £10,342,000 in 1901.

The figures of export were:—1901, £339,000; 1902, £278,000.

California.—The output of beet sugar in California has increased by leaps and bounds since 1893, when it was only 9,888 short tons. In 1901 the output was 68,700 short tons, and the crop of 1902 is somewhat larger, about 150,000,000 lbs. It is estimated that California produces sugar enough to supply seven-eights of the consumption of all the Pacific States, which is about 165,000,000 lbs. Out of a total acreage in the United States under beet of 260,000 acres, California can lay claim to 71,234 acres.

Argentina.

The sugar output has gone back nearly 8,000 tons, some 20 per cent. This business is said to be suffering from over-production, and a provincial law has been passed to restrict the production.

The average sugar output for the last five years has been 124,000 tons. The export has been 30,000 tons.

Brazil.

Pernambuco.—Return of exports from Pernambuco during the years 1900-02.

Articles.	Year.	United Kingdom. Tons.	United States. Tons.	Portugal. Tons.	Other Countries. Tons.	Native Ports. Tons.
White sugar and refined	1900	—	—	3	454	70,921
	1901	—	—	30	76	51,358
	1902	—	829	121	42	46,518
Muscovado sugar	1900	2,651	10,446	5	—	23,195
	1901	9,049	73,176	99	115	23,605
	1902	16,820	43,188	36	90	68,489
Centrifugal sugar, 96° polarisation	1900	—	900	—	—	—
	1901	651	16,940	5	—	230
	1902	111	3,784	—	—	3,236

Nicaragua.

There was a considerable increase in the export of sugar, and last year about 1,500 tons were sent to the United States and Vancouver.

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. Thompson, C.E., F.C.S., M.I.M.E., Chartered Patent Agent, 6, Lord Street, Liverpool; and 322, High Holborn, London.

ENGLISH.—APPLICATION.

14182. M. H. Miller, D. Huether, A. H. Hough, A. McNeill, and R. Fisher, London. *Improvements in the process of and apparatus for making sugar.* Complete specification, 25th June, 1903.

14519. I. Suzuki, Glasgow. *Improvements in apparatus for manufacturing rock candy sugar.* Complete specification, 30th June, 1903.

15274. W. T. Whiteman, London. (Communicated by the Syndicat pour l'Exploitation du Brevet Hlavati, Belgium.) *An improved process for extraction of the crystallisable sugar contained in saccharine liquids obtained from beetroot or sugar cane.* Complete specification, 10th July, 1903.

ABRIDGMENTS.

17912. C. A. Spreckels and C. A. Kern, New York, United States of America. *Improvements in the purification of sugar crystals and a product obtained thereby.* 14th August, 1902. This method or process of cleansing a mass containing sugar crystals consists in mixing therewith a sulphonated defecating or cleansing agent, then separating from the mass the said cleanser, together with the

absorbed impurities, then mixing the cleansed crystalline mass with a non-solvent of sugar for the purpose of removing remaining traces of the cleanser, and removing said non-solvent of sugar.

18301. G. F. Stickings, Sussex. *An improved sugar cane cutting or reaping machine.* 20th August, 1902. This invention consists in a sugar cane cutting or reaping machine having the following essential features: (1) A horizontal frame across which is a main shaft carrying loose clutch-operatable supporting wheels; (2) a spring beam carrying the fork of a steering wheel operatable by a suitably arranged worm and pinion; (3) two counter shafts at right angles to the main shaft and supported there-above on suitable frames; (4) a worm on each counter-shaft gearing with corresponding clutch-operatable worm wheels on the main-shaft; (5) a clutch-operatable sprocket wheel on one of the counter-shafts and a chain communicating movement from the said counter-shaft to a sprocket wheel on the other of the counter-shafts; (6) a motor supported within the said main frame, and having at one end of its crank-shaft a clutch for connecting it with a counter-shaft and at its other end a second clutch for connecting it with a spindle carrying outside the frame a crank disc—the crank-shaft, counter-shaft and spindle having co-incident axes; (7) a connecting rod having one end connected with a pin on the crank disc and the other end connected with a guide carrying the cutting knife and reciprocating on a rest supported at each end on rollers, and pivottally connected with the frame by an adjustable hanger; and (8) a cane gatherer at one end of the main-shaft.

19028. H. Claassen, Prussia, Germany. *Improved method or process for controlling the over-saturation in boiling saccharine solutions or syrups.* 29th August, 1902. A method or process of controlling the over-saturation in the boiling of saccharine juices or solutions, and especially thick or concentrated juices, which method or process consists in maintaining during the boiling process a systematically varying, empirically determined over-saturation corresponding to the purity of the saccharine solution, the over-saturation being decreased after formation of grain, and this decrease being then followed by a systematic increase of the over-saturation up to the boiling off, said increase corresponding to the decreasing purity of the mother-syrup.

9078. F. Meyer, London, E.C. (Communicated by J. W. Meyer, Trinidad, and J. Wardrop-Arbuckle, Trinidad.) *An improved means of evaporation for the concentration or condensation of syrups or similar fluids.* 22nd April, 1903. This invention consists in the use of a sparger or sprinkler in connection with the apparatus generally employed in the process of evaporation for the purpose of condensation or concentration of syrup or other similar fluid, either in vacuum or open-air form.

10124. M. Ekenberg, Stockholm, Sweden. *Improved method of and apparatus for concentrating and evaporating liquids.* 4th May, 1903. This method of evaporating in vacuum or under ordinary atmospheric pressure emulsions, solutions and the like to a dry condition, consists in concentrating the liquid, causing the same to flow from the chamber or place where it comes into contact with the cylinder-shaped rotary body mounted in the liquid receptacle, from which rotary body the dry residue produced by evaporation is scraped in a circulating current effected by means of a pump or the like, over suitable surfaces, especially the end walls, of the said body, so that it is frequently brought into contact with said surface under constant supply of heat.

GERMAN.—ABRIDGMENTS.

140870. R. Fölsche, Halle-on-Saale. *Method of and arrangement for conducting the juice in diffusion batteries.* 8th February, 1902. The method consists in the reconveyance of the juice from the freshly mashed diffuser to the previous one without the use of a pump, merely by the water pressure bearing on the last diffuser. For this object, juice pipes are so arranged that they are distributed in two parts by a valve being inserted between all the diffusers in order to enable the juice to flow simultaneously in two directions. By this means a reheating of the juice used for the mashing to from 80° to 90° is operated, which juice is then passed through the highly saccharine shreddings which have already been traversed twice by highly heated juice. The more diluted juice employed for mashing fresh shreddings is forced over by the pressure by means of the thicker mashing syrup instead of the thinner juice from the rear diffusers. The juice is only drawn off from the battery after it has been twice passed through the shreddings.

140991. Moritz Weinrich, Yonkers, New York, United States of America. *Apparatus for the constant purification of solid substances such as sugar, masse-cuite, salt, starch, paper pulp, &c.* 28th February, 1902. The apparatus consists essentially of a slightly inclined straining plate over which the substance to be purified is moved by means of scrapers suspended on endless chains. The separated, impure liquid (mother-liquor) flows away through the straining plate (which may if desired be heated), whilst the solid substance (crystals) may be washed by means of arrangements (perforated pipes) provided therefore by steam or other suitable casing fluid.

140992. Blake Barclay & Co., Greenock, Scotland. *An arrangement for supplying mother-liquor, more particularly the syrups of the sugar industry in vacuum pans.* 19th July, 1902. The arrangement consists in the mother-liquor being drawn by suction from a storage vessel into a preliminary heater communicating directly or indirectly with the chamber of said storage vessel, from which preliminary heater the mother-liquor flows by means of an

overflow pipe into the vacuum pan. By this means an uninterrupted supply of mother-liquor is provided for the vacuum pan, and at the same time it is possible to have an exact check over the temperature (by inserting a thermometer in the feed pipe).

140993. Dr. HEINRICH WINTER, Charlottenburg. *A stirring apparatus more particularly for boiling sugar juice.* 21st August, 1902. The stirring mechanism consists of drums or cages formed of tubular bars and arranged on a main-shaft. The tubular bars may be fixed or movable, and be checked in their freedom of movement by pointed stops and strengthened by ribs. By this peculiar arrangement the cages are rotated by the rotation of the main-shaft. The object of this arrangement is to allow of a thorough mixing from the shaft to the periphery and *vice versa*, that is to say a mixing of the coolest with the hottest particles of water.

141184. GEBRÜDER GLASS, Leipzig. *A vacuum drying apparatus for volatile substances having super-imposed heating bodies.* 31st January, 1901. The material to be dried flows through pipes in a thin layer over endless bands, the vessel being provided with heating bodies arranged at intervals apart. The bands which are not heated convey the dry goods into the discharge chamber passing round the heated bands lying beneath. In this manner any overheating of the material is avoided.

141240. ALBERT FESCA & Co., Maschinenfabrik & Eisengiesserei, Aktien-Gesellschaft, Berlin. *Centrifugal with a hood shaped drum bottom for receiving the regulator.* 25th April, 1901. The hood shaped part of the bottom of the centrifugal drum which part covers the regulator rests on a disc provided with a bevelled edge which disc is mounted on the driving shaft. On the shaft being rotated the drum is thus carried along with the disc by friction. If the shaft be suddenly stopped the drum slips unimpededly forward on the friction edge of the disc so that the drum is prevented bursting owing to too sudden stoppage.

IMPORTS AND EXPORTS OF SUGAR (UNITED KINGDOM,)

To end of June, 1902 and 1903.

IMPORTS.

Raw Sugars.	Quantities.		Values.	
	1902.	1903.	1902.	1903.
	Cwts.	Cwts.	£	£
Germany	3,646,696	1,802,718	1,278,622	727,108
Holland	211,041	130,415	68,300	49,006
Belgium	354,008	604,949	130,154	252,208
France	1,416,833	385,350	558,492	171,612
Austria-Hungary	52,515	1,322,727	18,036	556,205
Java	....	....	....	....
Philippine Islands	....	70,646	....	25,285
Peru	74,278	156,574	25,169	59,393
Brazil	498,928	65,186	161,278	25,505
Argentine Republic	513,885	101,326	189,898	44,176
Mauritius	185,672	222,170	67,866	78,546
British East Indies	62,580	101,215	25,425	36,491
Br. W. Indies, Guiana, &c.	966,208	466,333	569,443	288,310
Other Countries	87,051	382,896	35,985	180,842
Total Raw Sugars	8,069,695	5,812,505	3,128,688	2,494,687
Refined Sugars.				
Germany	7,599,768	7,023,726	4,032,687	3,641,671
Holland	1,268,941	1,040,730	739,823	600,791
Belgium	98,626	74,865	57,961	43,555
France	1,866,649	444,366	964,798	254,672
Other Countries	10,727	504,299	5,146	247,962
Total Refined Sugars	10,844,711	9,087,986	5,800,415	4,788,651
Molasses	646,066	748,019	125,006	142,134
Total Imports	19,560,472	15,648,510	9,054,089	7,425,472

EXPORTS.

British Refined Sugars.	Cwts.	Cwts.	£	£
Sweden and Norway	20,732	12,904	11,926	6,728
Denmark	68,144	50,420	35,147	27,674
Holland	31,151	31,051	16,346	16,900
Belgium	4,426	4,303	2,335	2,138
Portugal, Azores, &c.	5,081	4,005	2,678	2,162
Italy	12,702	5,422	6,009	2,467
Other Countries	149,820	280,668	94,357	169,714
	292,056	388,773	168,798	227,783
Foreign & Colonial Sugars.				
Refined and Candy	26,487	20,953	16,182	12,612
Unrefined	40,699	30,320	21,209	15,825
Molasses	1,189	1,206	421	616
Total Exports	360,431	441,252	206,610	256,836

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1903. Tons.		1902. Tons.
Total Receipts, 1st Jan. to July 16th ..	1,014,240	..	844,666
Receipts of Refined ,, ,, ,, ..	1,034	..	8,487
Deliveries ,, ,, ,, ..	930,534	..	833,843
Consumption (4 Ports, Exports deducted) since 1st January	829,336	..	831,216
Importers' Stocks (4 Ports) July 15th ..	88,091	..	36,134
Total Stocks, July 22nd	325,000	..	129,568
Stocks in Cuba ,, ...	297,000	..	359,000
	1902.		1901.
Total Consumption for twelve months ..	2,566,108	..	2,372,316

CUBA.

STATEMENT OF EXPORTS AND STOCKS OF SUGAR, 1902 AND 1903.

(Tons of 2,240lbs.)	1902. Tons.		1903. Tons.
Exports	325,184	..	569,298
Stocks	448,594	..	358,397
	773,778	..	927,695
Local Consumption (six months)	19,150	..	19,950
	792,928		947,645
Stock on 1st January	19,873	..	42,530
Receipts at Ports up to 30th June.. ..	773,055	..	905,115

J. GUMA.—F. MEJER.

Havana, 30th June, 1903.

UNITED KINGDOM.

STATEMENT OF IMPORTS, EXPORTS, AND CONSUMPTION FOR THREE YEARS.
From *Produce Markets' Review.*

SUGAR.	Imports. 1903. Tons.		Imports. 1902. Tons.		Imports. 1901. Tons.	Exports (Foreign). 1903. Tons.		Exports (Foreign). 1902. Tons.		Exports (Foreign). 1901. Tons.
Refined, Jan. 1st to June 30th.	87,525	..	45,243	..	53,060	393	..	385	..	506
Raw, ,, ,,	49,110	..	32,703	..	19,226	322	..	660	..	1,200
Molasses, ,, ,,	5,885	..	6,484	..	7,168	4	..	2	..	22
Total	142,520	..	84,430	..	79,454	719	..	1,047	..	1,728

HOME CONSUMPTION.

	1903. Tons.		1902. Tons.		1901 Tons.
Refined, Jan. 1st to June 30th	84,697	....	42,976	....	—
Raw, ,, ,, ...	46,775	....	23,742	....	—
Molasses, ,, ,, ...	3,515	....	4,666	....	—
Total	134,987	....	71,384	....	—
Less Exports of British Refined	5,134	....	2,519	....	—
Net Home Consumption of Sugar	129,853	....	68,865	....	93,304*

* Trade estimate.

STOCKS OF SUGAR IN EUROPE AT UNEVEN DATES, JULY 1ST TO 22ND, COMPARED WITH PREVIOUS YEARS.

IN THOUSANDS OF TONS, TO THE NEAREST THOUSAND.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	TOTAL 1903.
109	817	570	253	161	1911

	1902.	1901.	1900.	1899.
Totals	2043 ..	1143 ..	981 ..	1178

TWELVE MONTHS' CONSUMPTION OF SUGAR IN EUROPE FOR THREE YEARS, ENDING JUNE 30TH, IN THOUSANDS OF TONS.

Great Britain.	Germany	France.	Austria.	Holland, Belgium, &c.	Total 1902-03.	Total 1901-02.	Total. 1900-01.
1590	854	572	396	501	3914	4157	4190

ESTIMATED CROP OF BEETROOT SUGAR ON THE CONTINENT OF EUROPE FOR THE CURRENT CAMPAIGN, COMPARED WITH THE ACTUAL CROP OF THE THREE PREVIOUS CAMPAIGNS.

(From Licht's Monthly Circular.)

	1902-1903. Tons.	1901-1902. Tons.	1900-1901. Tons.	1899-1900. Tons.
Germany	1,750,000 ..	2,304,924 ..	1,984,186 ..	1,798,631
Austria	1,070,000 ..	1,302,038 ..	1,094,043 ..	1,108,007
France	890,000 ..	1,183,420 ..	1,170,332 ..	977,850
Russia	1,215,000 ..	1,098,983 ..	918,838 ..	905,737
Belgium	230,000 ..	334,960 ..	393,119 ..	302,865
Holland	105,000 ..	203,172 ..	178,081 ..	171,029
Other Countries.	345,000 ..	393,236 ..	367,919 ..	253,929
	5,605,000	6,820,733	6,046,518	5,518,048

THE

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☞ The Editor is not responsible for statements or opinions contained in articles which are signed, or the source of which is named.

The End of the Bounties.

It is with the greatest pleasure that we are able to chronicle the passing into law of the British Sugar Bill to give effect to the provisions of the 1902 Brussels Convention. A long standing injustice to an old established British industry has at length met with tardy recognition, but so tardy that some of those who have been associated with the question for long years became pessimistic enough to doubt whether that incubus of fair trade, the bounty system, would ever be done away with. This was not surprising when we remember that the failures of one Convention after another were recorded with the regularity of recurring decimals, and always for the same reason, that England as a whole clung so persistently to her fetish of free trade that she would not for a moment tolerate any suggestion of levying a countervailing duty on bounty-fed sugar. Hence the repeatedly abortive attempts. But within the last five years a change seems to have come over the minds of our leading men; old theories have been dismounted from their pedestal to make room for more modern ones; economical pedantries have ceased to hold such a sway as heretofore, and questions are beginning to be investigated on broader lines. It was not surprising then that the injustice to which the British and Colonial sugar industry had been subjected for half a century was at length seen in its true light, and that the only possible means were then taken to put an end to an iniquitous system that threatened to spread to other industries. Neither was it surprising that the opposition, whose main argument was that the jam and

confectionery trades would be ruined if bounties were abolished, failed signally in their attempt to wreck the measure, when we consider that on their own showing these industries are bolstered up by the worst form of protection there is, protection to the foreigner in our own markets; well might Mr. Chamberlain express his preference for an industry which asked only for fair trade in order to exist.

But the new era has at length dawned, and with it should come that necessary factor for success, security. Mr. Chamberlain complained lately that he has for some time past been trying to get financiers to interest themselves in the West Indies, but the latter had always felt that it was too risky an experiment so long as bounties existed. Now that the latter are to be a thing of the past, it is to be hoped that those individuals will reconsider their position. Should sufficient money be forthcoming, we may expect to see central factories of the most modern construction and equipment erected in the West Indies within the next few years, and the present output of 250,000 tons may increase three if not fourfold. The advantages resulting to British trade should be considerable; increased cargoes between the United Kingdom and the Colonies; increased output of sugar machinery, and increased supply of raw sugar for home refineries to work up. But we have no wish to paint too rosy a picture at so early a date. It is not to be supposed that matters will right themselves all at once: the diversion of trade from one source to another will take time. The increase in the size of the plantations and mills will be a question of years, and we are quite prepared to be told twelve months hence by our opponents that, in spite of the abolition of bounties, no appreciable increase in the exports of West Indian sugar has taken place. But while that may or may not be so, there is no doubt that we may look forward at an early date to increased supplies of foreign cane, and these will be decidedly preferable to Continental beet, for, in spite of the analyses of chemists, there is no doubt cane sugar is more nourishing than beet. But wherever our supply may come from, it will be amply sufficient to keep down the price at its present level. The immediate effect of the Convention will be to prohibit the importation of sugars from Russia, Argentina, and Denmark; a matter of perhaps 50,000 out of a total of over $1\frac{1}{2}$ million tons required in this country. This deficit could be more than made up merely by diverting some of the West Indian supplies at present going to the U.S.A. There is reason, besides, to suppose that both Argentina and Denmark will follow Peru's example and bring their fiscal arrangements in harmony with the principles of the Brussels Convention. Russia, the sole country remaining liable to penalties will doubtless persist in retaining her bounties, and will confine her exports to her Eastern dependencies.

Some Arguments.

It is curious how paradoxical are some of the arguments that have been advanced by the opponents of the sugar industry in favour of the retention of bounties. On the one hand, we are gravely told that as one result those countries which participate in the Convention will secure a monopoly of the sugar trade, and therefore raise prices. On the other hand, the suggestion that, had bounties continued, Germany and Austria would, sooner or later, have secured a monopoly of the world's sugar trade, has long been ridiculed as an impossibility, because there was a plentiful supply of sugar always available from other parts of the world. In the first case we are to believe that four or five countries, competing under conditions of practically fair trade, can secure a monopoly in our sugar markets over all the remaining sugar-producing countries, because perchance two or three of the latter now render their share liable to prohibition, and in consequence reduce our available supply by less than $\frac{1}{125}$ of the world's production. In the second case we are told that in spite of their enormous bounties (State and Cartel), enabling them to sell sugar at a profit *below cost price*, Germany and Austria could not possibly secure any monopoly of the sugar trade while so many other sources of supply were available. One presumes, then, that these other sources of supply would be actuated by such philanthropic motives that they would continue indefinitely to sell their *unbountied* sugar similarly below cost price, so as to keep up the amount of the world's available supplies. It seems to be generally overlooked that even in such progressive countries as Java and Hawaii the price of sugar has become so low since the Cartel bounties were instituted a year or two back, that profits, if any, have been very small, and a continuation of this state of affairs would have been, in many cases, little short of disastrous. Indeed, most individuals engaged in the sugar industry in those countries will welcome the abolition of bounties, knowing that it will ensure a more stable and natural market price for their sugar.

Jam making as an "Industry."

"We have not heard so much about jam since Mr. Gladstone told the British farmer to seek salvation in that commodity. Mr. Robson and others were eloquent last night about jam, and extremely sympathetic with the confectioners whose enterprise is said to be the despair of the German jam makers. How long can he guarantee the British confectioner against measures for depriving him of power to invade the German market? It is pretty certain, judging from experience in every other department, that as soon as the British jam trade becomes worth fighting it will be effectively attacked. The people who are so very solicitous about jam—one of the most assailable of industries, because it needs no great amount of capital,

science, or skilled industry—are perfectly indifferent to the fate of British sugar refining and Colonial sugar producing, both of which demand a liberal supply of all three. One point which should not be lost sight of in the fiscal inquiry is the relative importance of different forms of industry to a nation. It is not enough to show that we maintain a certain level of exports if we do it only by letting go the highly organised industries and sinking to the production of miscellaneous things demanding only the lowest forms of mental ability and of industrial aptitude. Jam is poor business for a great industrial community in comparison with things calling for the co-operation of classes of highly trained workmen, but jam in any case is not endangered by the Sugar Convention."—(Extract from *Times* leader.)

ERRATA.—Owing to an unfortunate error, the figures given on page 415 of our last issue, under "United Kingdom, Statement of Imports, Exports, and Consumption," were those for the month of June only, instead of for the six months ending June 30th.

THE SUGAR CONVENTION BILL.

DEBATE IN THE HOUSE OF COMMONS.

As briefly recorded in our last issue, the Sugar Convention Bill came up for its second reading in the House of Commons on July 28th. It was introduced by Mr. Gerald Balfour, who reminded the House that the country was pledged to the principle of the measure, as it had obtained the sanction of Parliament, and we could not very well withdraw from it without raising discredit. He dealt with some of the criticisms levelled at the Bill, and reminded the members of the declaration of the Government that they would not under any circumstances consent to penalize bountied sugar coming from our own colonies. Against only four countries did it seem probable that we should have to apply prohibition; these were Russia, Argentina, Chile, and Peru. But as the amount of sugar coming from these countries was relatively small, it would not materially affect our supplies. He further adduced arguments with the object of showing that the average price of sugar during the next ten years would not be higher than it was in the decade previous to the Convention.

Mr. Lough led the opposition, and was supported by Mr. Gibson Bowles; they both reiterated the old argument that the price of sugar would be serious raised if the Bill came into force, inasmuch as the countries participating in the Convention would have a monopoly of the sugar trade with the United Kingdom.

Mr. Bonar Law defended the Bill, and said, amongst other things, that there had been enormous changes in the trade of the world

during the last decade, and that it was high time Parliament began to think about altering its theories to make them conform with facts.

The debate was continued next day, when the Bill was further condemned by various members, on the score that it would be bad for the consumers, that it was a breach of the most-favoured-nation-clause with Russia, and finally that it was an insidious attack on the principles of free trade. This last argument was advanced by Mr. Winston Churchill, who, passing by the main points involved, tried to make the Bill the basis of a more or less personal attack on Mr. Chamberlain and his alleged fiscal policy. He stigmatised it as the forerunner of the great scheme for increasing the price of food in the interests of the colonies.

The Bill did not lack supporters. These included Mr. M. W. Ridley, Mr. Platt-Higgins, Mr. Boscawen, Mr. Austen Taylor, Mr. W. F. Lawrence, Mr. Reid, Mr. Duke, and Sir W. Thorburn; but it was not till Mr. Chamberlain came to its aid that the tide of opposition, which had been running rather strong, was really stemmed. He began his speech (to quote the *Times* summary) with a trenchant declaration to the effect that it would be contrary to all usage to repudiate a Convention to which the House had assented by resolution and which the Government had ratified. He went on to justify the policy of prohibiting the importation of bounty-fed sugar, pointing out, however, that countervailing duties might be substituted as an alternative for prohibition, if that should be preferred. The complaint that we had only one representative on the Commission he met by calling attention to the fact that the other Powers concerned had each the same representation. After denying that the formation of an international cartel could in the circumstances of the future do us any injury at all, he advised his opponents who believed that we were on the eve of a great economic fight to keep cool, and not to give the contest a personal character. He then described the Bill as one that secured what for 40 years every economist and representative man of eminence had regarded as a desirable object to attain. Bounties fostered unfair competition, enabling goods to be "dumped down" in this country below cost price to the detriment of British industry. For 20 years and more the bounties had grown in magnitude, and it was only when retaliation was threatened that foreign countries agreed to abolish them. In Germany bounties had led to an enormous development of the beet sugar industry, and that country had hoped, through their operation, to create with Austria a monopoly of the trade. This would have enabled Germany to regulate the price of sugar here. Did not that alone justify the course which the Government had taken? The interest of the community was to have sugar as continuously as possible at the lowest possible price for which it could be produced without loss. This he believed the community would obtain under the Bill, and he

also agreed with the President of the Board of Trade that the removal of the bounties would secure greater stability in price. Noticing predictions which had been made as to the effect of the Convention on particular industries, he said he believed that, if the average price remained about the same as it was now, the fruit preserving and jam industry had nothing to fear. He then showed that in Great Britain the refining industry, about which there was so much alarm, had remained stationary while the bounties operated, although foreign refiners had multiplied their business sevenfold. And yet, he observed, we were told that under our free trade system everything was for the best in the best of all possible worlds. As to the West Indies, they would be helped by the trade stability which stable prices would ensure. He appealed to the House not to let it get abroad that Parliament was indifferent to the interests of the colonies. When a part of the Empire suffered an injustice we ought to remedy it, even at the cost of some sacrifice, if sacrifice was entailed. Summing up his main contentions, he asked the House to pass the Bill, because to reject it would be to perpetrate an act of bad faith, because it would secure free trade in sugar and increase the sources of our supply, because it would protect us against monopoly, and because it would repair an injustice to the West Indies.

Some parts of his speech are of such interest and importance, that we reproduce them in full below, as they appeared in the *Times*:—

When hon. gentlemen opposite undertake to explain that the bounties have nothing to do with the ruin of refiners or the failure of people in the West Indies, they say that the real explanation is the superior science of foreign countries. It is the Charlottenburg argument. If we can only establish a school in this country like the school in Germany, which has educated all these scientific Germans to such a height that they entirely surpass our own people, then all will be well. But does the science of the French, Germans, and other Powers concerned stop the political economy? Are they so wise in their methods of business, so admirable in their applications of science, and such idiots in regard to the larger considerations of political economy that anyone can instruct them better—that the schoolboy can teach them the A B C of the science of which apparently they have not the slightest conception? To my mind that is a ridiculous supposition. I believe the Germans and the French are clever people, and I have an idea that they do understand their interests, and that they do know enough of political economy not to be carried away by all the dogmas which hon. gentlemen opposite would wish us to accept. What has been the result of the bounties to Germany, for instance? Has the system ruined Germany? No. It has paid Germany well. What has happened? An enormous development of trade, and not only of the growth of beet, by which hundreds of thousands of people have been employed on the land, but all the trades which are connected with the growth of beet, the machinery trade, the mechanical production of all these trades are benefited in like measure. That is the present immediate result of paying the bounties in Germany. I think, therefore, people might find that the Germans are not so foolish as some hon.

gentlemen suppose, and that on the whole they have already done very well. But that is not all. They are looking forward to greater success. What is the ultimate object of a bounty? It is to secure a monopoly. Was the bounty in process of securing a monopoly? Yes, it was. If you look at the returns you will find that the increase of the importation of sugar into this country from Germany and Austria has been perfectly enormous, and that we were on the rapid road to a condition of things in which Germany and Austria alone, without any international cartel such as that which frightens the hon. and learned gentleman the member for South Shields, would have been able to regulate the price of sugar in this country. Do you suppose they would not have taken advantage of that? Do you suppose the working people of this country are such fools as not to know that it would be worth almost any present sacrifice to prevent the creation of a monopoly of which ultimately they will be all victims? That is one reason, and it is a very good reason, why the old economists were opposed to "dumping."

. . . . . .

We have heard a great deal, as I have said, about the jam trade. The hon. member for Islington gave us really a most picturesque description of the brilliant fortunes of this interest. He told us of the millions that had been expended upon it, of the large fortunes that were being made, and of the numbers of working people who were being employed. Well, I suppose the people who are engaged in these industries and who have spent these millions are what are called capitalists. If so, why is the hon. gentleman so severe on the sugar capitalists?

Mr. Lough.—I am not at all severe.

Mr. Chamberlain.—I beg pardon; the hon. member went on to sneer at Sir Nevile Lubbock, whom he named, and others whom he called sugar capitalists. For the life of me I cannot see that a sugar capitalist is a bit better or a bit worse than a jam capitalist. (Mr. Lough—"Hear, hear.") Well, so far we are agreed. Well, what is the jam industry? I am not going to deal with persons, but with industries. The jam industry, which has been spoken of in such dithyrambic language, is a protected industry of the worst kind—a protected industry according to the hypothesis of hon. gentlemen opposite. Mind, I am not quite certain that I accept that hypothesis, but according to it the jam industry is a protected industry which could not live unless it could buy sugar below cost price, and that sugar is only provided for it by the bounty system of foreign nations. Now, if I am to compare industries, I say that the West Indian industry, which asks only for free trade and fair trade, is after all more deserving of consideration than the jam industry, which lives on bounties and on the ruin of other trades in this country. But I do not accept the hypothesis. I do not believe that the jam trade is in the slightest danger.

. . . . . .

It seems to me that, if we had not taken these steps and shown foreign nations that we will not stand bounties, that we will retaliate against them and take all the steps necessary to prevent them, the policy of bounties would have had a great development. I cannot conceive why the Germans, French and Austrians, who have put on bounties to secure to themselves the sugar industry, which is a primary industry, should not also put on bounties

to secure the jam industry, which is a secondary industry. One thing is clear, that if they had done so, according to the arguments which hon. gentlemen are using, the jam industry would have had no right to complain. They at any rate have no call upon us. They repudiate any retaliation against bounties, and if now or hereafter these trades suffer in any degree—and I think it is not impossible that they may suffer—at all events we know that on their own showing no Parliament will be called upon to legislate in their favour.

At the conclusion of Mr. Chamberlain's speech the House divided on the Bill, and the second reading was carried by a majority of 80 (224—144).

The concluding stages of the Bill did not present any difficulties, and it passed both Houses, and received the Royal Assent before the Session terminated.

SUGAR CONVENTION REGULATIONS.

A recent number of the *London Gazette* published particulars of the new sugar regulations coming into force on the 1st of this month. The sugars from Denmark, Russia, and the Argentine Republic (not including molasses and sugar-sweetened products), will (unless already in transit) be prohibited from entry into the United Kingdom on and after that date. Another Order in Council prescribes: "That, from and after the first day of September next, inclusive, every sugar factory and sugar refinery and factory for the extraction of sugar from molasses in the United Kingdom shall be under the supervision either of the Commissioners of Customs or of the Commissioners of Inland Revenue."

The regulations are six in number; they are given as follows:—

Regulation I.

All sugar (other than molasses and sugar-sweetened products) imported or brought into the United Kingdom from any place outside the same, shall be accompanied by such evidence of origin as hereinafter required; and all such sugar imported or brought into the United Kingdom not accompanied by such evidence shall be deemed to be so imported or brought in contrary to a restriction contained in section 42 of the Customs Consolidation Act, 1876, and subject as hereinafter provided, shall be dealt with accordingly, as if the same were goods enumerated and described in the table to the said section.

Regulation II.

The evidence of origin required shall be in accordance with that laid down by the Permanent Commission in certain Articles agreed to by them for due observance of the Convention, so far as the same are applicable to the United Kingdom; that is to say:—

All sugar (other than molasses and sugar-sweetened products) shall be accompanied by a certificate of origin indicating (*a*) the kind and quantity of the sugar, (*b*) the kind, number, and marks of the packages, (*c*) the country of production, of origin, or of manufacture, and the country of destination of the goods, and (*d*) the mode of carriage by land or water.

REGULATION III.

The certificate must be signed, and issued, by the fiscal authority having jurisdiction in the country of production, of despatch, or of transformation, such fiscal authority being duly empowered for that purpose by the Government of the State.

REGULATION IV.

When the country of origin of any sugar the subject of a certificate is a State not party to the Convention, the certificate must, in addition to the particulars required above, state that the goods are derived from a factory which does not work sugar coming from either Russia, Denmark, or the Argentine Republic; and any such certificate must, as a guarantee of due signature and issue, be viséd by the proper British Consul or Vice-Consul.

REGULATION V.

No certificate is to be deemed valid after the expiry of twelve calendar months from the date of its issue, or such less time (if any) as may be mentioned in the certificate by the fiscal authority issuing the same.

REGULATION VI.

Inasmuch as it is possible that sugar may occasionally reach the United Kingdom before the arrival of the certificate of origin relating to the same, and it would be inconvenient and expensive to importers if such sugar were not delivered from Customs charge until the arrival of the certificates, it shall be competent for the Commissioners of Customs to authorise the delivery of such sugar, on the security of a deposit of such amount or of a bond in such penalty as they may think fit, for the due production of the necessary certificate within a prescribed period, provided that they see no reason for suspecting that the sugar emanates from a prohibited country.

The death is announced of Mr. A. A. Denton, of Medicine Lodge, Kansas, who was well-known by his life-long devotion to the interests of sorghum. He was a man of rare intellectual attainments, and his decease will come as a loss to the American sugar industry. Numerous papers have appeared from his pen on sorghum; the last in our journal was in Vol. III., p. 207.

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THE CARBONACEOUS MATTER OF ANIMAL CHARCOAL.*

BY T. L. PATTERSON, F.I.C., F.C.S.

(Continued from page 406.)

Preparation of the Organic Body, its Properties and Analysis.—In order to study more completely this brown organic body, a large portion of charcoal dust was treated with hydrochloric acid, washed by decantation, and thoroughly dried. The following figures were obtained on analysis:—

Carbonaceous matter..	87·82	Containing nitrogen ..	7·80
Organic body soluble in H_2SO_4..	6·00	,, ,, ..	0·74
Sand	6·00		
	99·82		8·54
		Total nitrogen directly estimated..	8·65

By calculating off the sand we get the composition of the carbonaceous matter insoluble in hydrochloric acid, as follows:—

Carbonaceous matter..	93·44	Containing nitrogen ..	8·30
Organic body	6·38	,, ,, ..	0·79
	99·82		9·09
		Nitrogen direct	9·21

The dried carbonaceous residue from the hydrochloric acid treatment was further digested with cold sulphuric acid to separate the organic matter. The acid filtrate was poured into water, and the precipitated organic matter washed by decantation, and finally collected on a filter, scraped into a porcelain basin, and dried. The operation is tedious, but I finally obtained 2 to 3 grms. of the organic body. In the process of washing to obtain the pure body it was noticed that after five washings by decantation the precipitate would not settle, but remained in suspension or in colloidal solution in the next washing water, and sulphuric acid had to be added to throw it down again. Washing with water on the filter does not dissolve the precipitate when the acid is removed, although it carries it through mechanically if stirred up in doing so; but the organic matter separated by sulphuric acid at 100° C. goes freely into colloidal solution on the filter as the acid is washed out and separates again after long standing.

In the dry condition the organic body presents a horny appearance with conchoidal fracture. Heated in a test tube it chars very easily, giving off whitish yellow vapours with a strong smell of burnt bones. Thrown into water it does not again assume the hydrated condition.

* From the Journ. Soc. Chem. Industry, Scottish Section.

It is insoluble in water, cold or hot; and insoluble in alcohol, ether, benzine, and chloroform. It dissolves freely in sulphuric acid, from which it is thrown down by water in the gelatinous condition, but the acid solution has a reddish colour, not yellow like the dilute acid filtrate from the first sulphuric acid separation, which indicates some slight change due to the treatment. Concentrated hydrochloric acid dissolves the hydrated body in the cold to a brown solution. Boiling makes little difference. Dilution with water throws it down again, from which a filtrate is obtained with a very slight yellow colour. Boiled with concentrated nitric acid, free from nitrous acid, the body dissolves with liberation of a little nitrous acid, to a brown solution. On dilution with water a portion of the substance precipitates, leaving the solution yellow. The addition of ammonia does not increase the colour of the filtrate, as it would if proteids were present. Neither does Millon's test give any reaction for these bodies. Glacial acetic and citric acids have very little action. Tannin does not produce any precipitate in the colloidal solution referred to above, but aluminium, iron, copper, mercury, and magnesium salts do. They do not precipitate the dilute sulphuric acid solution, perhaps because so little substance is present. Strong ammonia dissolves the hydrate freely, and dilution does not precipitate it, but it falls out partially on heating, leaving a yellow solution which deposits a few yellow needle-like crystals when evaporated to dryness. This reaction points to the body having the properties of an acid in very dilute solution, whilst it has those of a base in the original charcoal.

The dried organic body is only very slightly soluble in strong ammonia, but ammonia does not separate any of it from the carbonaceous residue of charcoal. It is insoluble in soda solution. It neither contains sulphur nor ash. A 50 per cent. solution of sugar shaken with the dried organic body dissolves a very little to a brownish colour, which remains brownish when diluted.

The following results were obtained on analysis of the organic body:—I. 0·2262 grm. gave 0·5217 grm. CO_2 and 0·0861 grm. H_2O. II. 0·2024 grm. gave 0·4738 grm. CO_2 and 0·0797 grm. H_2O; and by the Kjeldahl process:—I. 0·5262 grm. gave NH_3 = 4·485 c.c. normal H_2SO_4 solution. II. 0·4866 grm. gave NH_3 = 4·160 c.c. normal H_2SO_4 solution. Worked out, these figures give the following percentages:—

	Experiment. I	Experiment. II.	Ox Bone Cartilage.
Carbon	62·90	63·26	49·81
Hydrogen	4·23	4·37	7·14
Nitrogen	11·98	11·97	17·32
Oxygen	20·89	20·40	25·67
	100·00	100·00	99·94

These results correspond with the empiral formula $C_{25}H_{20}N_4O_6$ The decomposition and oxidation products have not yet been studied. But since we know the body itself to be a decomposition product of bone cartilage, I have put alongside an analysis of the latter by Frémy (Watt's Dictionary, Vol. I., p. 620) for comparison. It is apparent from this analysis that decomposition has not proceeded far, or at any rate so far as we might expect, when we recollect that the bones must have been submitted to a red heat for at least 12 hours in reducing them to charcoal. The large percentage of oxygen, which, with its equivalent of hydrogen form the elements of 23 per cent. of water, might lead us to infer that this substance is a product of the action of the sulphuric acid on the carbonaceous matter, or that it is due to the organic body holding added water so tenaciously that a temperature of 100° C. is incapable of drying it. Had the action been the result of oxidation or hydrolysis the weight of the organic body would have been considerably increased, and the analysis of the carbonaceous residue from hydrochloric acid, given above, would have shown this. But the three constituents of that residue were estimated directly, and they total rather under 100. We have seen that no heat is developed and no gas liberated when this residue is treated with sulphuric acid, as would have been the case had the acid acted chemically on it, and had it contained uncombined water. Much heat is liberated when the residue is not dry from the combination of the acid with the water present. The action seems to be a simple case of dissolution on the part of the acid. We must, therefore, conclude that the oxygen is a constituent element of the organic body, and that it exists in the charcoal itself, as it does in the bone cartilage. I am not aware that oxygen has previously been observed as a constituent of charcoal, but its presence accounts for the fact that at all temperatures up to 300° C. water can be driven off.

Discussion of the Loss which Charcoal and Carbonaceous Matter sustain on Heating.—The following experiment may be cited as evidence of this, and of the decomposition which goes on when charcoal is heated at high temperatures. A quantity of No. 1 charcoal—about 22 grms.—was introduced into a small flask with side tube, the bulb of which was just filled. The contents were then submitted to dry distillation, by suspending the flask in a water-bath and heating to 100° C. for 10 hours. The water which distilled over was collected in a receiver for examination. It was alkaline to litmus, and a bubble or two of carbonic acid was liberated on the addition of a drop of hydrochloric acid. Evaporated to dryness it left a faintly yellow-coloured residue of chloride of ammonium. A thermometer was now inserted, and the flask and its contents heated with a bunsen flame successively to, and maintained for 15 minutes at, temperatures of 150° C., 200° C., 250° C., and 300° C. In each case there was a watery distillate which had an ammoniacal smell, turned litmus paper

blue, and with the exception of the portion recovered at 150° C., effervesced strongly on the addition of hydrochloric acid. The distillate at 150° C. effervesced very slightly. All the acidified distillates left a yellowish residue of chloride of ammonium on evaporation.

The actual loss at these temperatures was the object of the next experiment. Weighed portions of two new charcoals, II. and III., stock charcoal which had been in use eight weeks, VI., spent charcoal, VIII., and portions of the carbonaceous residue from hydrochloric acid and from sulphuric acid, were heated for an hour in an air-bath fitted with a regulator to the temperatures of 150° C., 200° C., 250° C., and 300° C., and the loss of weight occurring between these temperatures recorded. All were dried at 100° C.

	Losses Per Cent.					
	II.	III.	VI.	VIII.	HCl Residue.	H_2SO_4 Residue.
100°—150° C.	1·05	0·97	0·72	0·10	1·23	1·66
150°—200° C.	0·54	0·51	0·41	0·00	0·38	0·57
200°—250° C.	1·17	0·91	0·82	0·10	1·92	1·58
250°—300° C.	1·44	1·15	1·10	0·08	3·17	3·01
Total 100°—300° C. . .	4·20	3·54	3·05	0·28	6·70	6·82
Total separated organic matter	4·11	3·35	1·35	0·02	6·00	. .

The experiment shows that carbonaceous matter as well as charcoal suffers loss at all temperatures over 100° C. up to 300° C., and that the total loss bears some proportion to the amount of organic matter which the sample contains. No. VIII., with 0·02 per cent. of soluble organic matter, only loses 0·28 per cent. of its weight at 300° C., whilst No. II., with 4·11 per cent. soluble organic matter, loses 4·20 per cent. The carbonaceous matter insoluble in sulphuric acid, which contains no soluble organic matter, loses rather more than does the portion insoluble in hydrochloric acid, which points to the large quantity of organic bodies which it must still contain in the insoluble condition. The portion insoluble in hydrochloric acid, containing 6·00 per cent. of the organic body soluble in sulphuric acid, lost 6·70 per cent. at the high temperature. As it seemed instructive to ascertain which constituent suffered the loss, the residue from this portion was submitted to analysis. The following is the result with the analysis of the same carbonaceous matter before heating to 100° C., placed alongside for comparison :—

	Before Heating.		After Heating.
Loss between 100° C. and 300° C. ..	..	..	6·69
Carbonaceous matter	87·82	..	89·56
Organic matter soluble in H_2SO_4 ..	6·00	..	0·24
Sand	6·00	..	6·00
	99·82		102·49

It will be noticed that the sum of the constituents of the heated portion total about 2½ per cent. over 100. This is due to the retention of water by the carbonaceous matter, a peculiarity which we will return to presently. Meantime observe the change which has taken place in the composition of the carbonaceous matter on heating to 300° C. Nearly the whole of the organic matter soluble in sulphuric acid has disappeared. The dry distillation experiment proves that water, carbonate of ammonia, and a little organic matter are given off at all temperatures over 150° C., and water, ammonia, and organic matter at lower temperatures. The results of both experiments are evidences of decomposition and probably of oxidation. But oxidation of the more highly carbonised portions of the carbonaceous matter does not take place at these temperatures, since No. VIII., which contains so little soluble organic matter loses practically no weight. The action seems to be confined to that portion of the carbonaceous matter which is soluble, or partially soluble, in sulphuric acid—that is to say, to the portions which are less highly carbonised.

These experiments demonstrate what I said in the early part of this paper, that charcoal goes on losing water the higher and longer it is heated. But although it is very probable the water lost is a constituent part of the carbonaceous matter, I am not quite satisfied that it really is so, since experiments can be cited which point in the opposite direction. When charcoal dried at 150° C. or 200° C. is moistened and again dried at 100° C., it retains a portion of the added water equal to that lost at the high temperature. Thus the four portions of charcoal used in the last experiment were treated in this way after each heating. The weights are recorded in the following table, in percentages:—

	I.		II.		VI.		VIII.	
	Lost.	Re-gained.	Lost.	Re-gained.	Lost.	Re-gained.	Lost.	Re-gained.
° C.								
At 150	1·05	1·16	0·97	1·00	0·72	0·68	0·10	0·13
At 200	1·59	1·59	1·48	1·49	1·13	1·08	0·10	0·14
At 250	2·76	2·06	2·39	1·89	1·95	1·43	0·20	0·23
At 300	4·20	2·22	3·54	1·97	3·05	1·60	0·28	0·23

At 150° C. the new charcoals lose about 1 per cent. of their weight, but on moistening with water and drying at 100° C. they regain that 1 per cent. The stock and spent charcoals lose less, but they too recover in weight all that was lost on moistening and drying at 100° C. The same remark applies to the charcoals heated at 200° C., only in this case they lose and recover more weight under the same conditions. When the temperature is raised to 250° C. the loss is much greater, and the charcoals, except in the case of VIII. which is spent, are unable to regain all the weight lost at the high temperature. The difference is one-half per cent. to three-quarters per cent. on all the charcoals except VIII. This inability to regain lost weight is still more apparent in charcoals heated to 300° C., in which case only about one-half of the loss is recovered at 100° C. The carbonaceous matter in VIII. has been so thoroughly carbonised by the repeated reburnings of several years that heating, even to 300° C., makes very little difference on it. At all temperatures except 300° C. it regains rather more weight at 100° C. than the fraction which it lost at the high temperature. These heating experiments explain the cause of the carbonaceous matter insoluble in hydrochloric acid, which had been heated to 300° C., coming out on analysis $2\frac{1}{2}$ per cent. over 100. The $2\frac{1}{2}$ per cent. is the measure of the water which it would retain after moistening with water and drying at 100° C.

It would seem from these experiments then, that animal charcoal may be assumed to be capable of withstanding a temperature of 150° C. to 200° C. without decomposition, since it can reabsorb and retain at 100° C. water equivalent to the weight it lost. But against this assumption I am inclined to place the evidence of the dry distillation experiment, in which ammonia, carbonate of ammonia, and organic matter, which are the result of decomposition, accompanied the water expelled at these temperatures. It may be that the water is so loosely combined that it is easily driven off at the high temperature, and enters as easily into combination at the low temperature; and that the quantities of ammonia, carbonate of ammonia, and organic matter expelled are so little, that decomposition is trifling and does not materially influence the results at temperatures up to 200° C. I am inclined to believe that this is the case, but I feel that further experiments are needed to clear up this and one or two other points. Water, for instance, is added to charcoal in the process of manufacture to keep down dust, &c. It would be interesting to know whether or not this added water passes partly into chemical combination and at what temperature it can all be liberated. We want also to know just how much of the water in the charcoal is due to this cause, and how much to the breaking up of the nitrogenous carbonaceous matter containing oxygen, present in the charcoal itself.

Analyses of Charcoals.

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.
Carbonaceous matter	18·22	14·47	8·84	9·72	10·13	11·36	16·25	5·05	17·05
Organic matter soluble in H_2SO_4 .	1·97	2·09	1·90	1·70	0·27	0·29	0·40	0·02	0·04
,, ,, ,, HCl ..	1·37	1·59	1·33	1·46	0·55	1·06	0·97	..	..
,, ,, ,, water ..	0·44	0·43	0·12	0·28	0·56	..	..	..	..
CO_2 lost on ignition	2·00	2·96	3·02	2·98	2·12	1·77	1·11	..	0·07
Ash	76·00	78·46	84·79	83·86	86·37	85·52	81·27	95·03	82·82
	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·10	99·98
Total CO_2	2·48	3·50	3·53	3·16	2·45	2·07	1·61	0·09	0·25
N in carbonaceous, and H_2SO_4 organic matter	1·85	1·75	0·99	0·84	0·55	0·67	0·71	..	..
N in HCl and H_2O organic matter.	0·51	0·33	0·10	0·26	..	0·18	0·07	..	..
Total nitrogen	2·36	2·08	1·09	1·10	..	0·85	0·78	0·15	0·66

No. I. is the dust from new charcoal. Nos. II., III., IV., and V. are new charcoals. No. VI. is refinery stock charcoal which has been 8 weeks in use. No. VII. is refinery stock charcoal which has been in use for 35 weeks. Nos. VIII. and IX. are spent charcoals turned out of refineries as useless.

The proper temperature for the estimation of water in charcoal is a very important one, not only because of its refraction value, but because of the influence it has on the analysis. When, for instance, charcoal is dried at 150° C. the above experiments show that it loses 1 per cent. more weight than it does at 100° C. But the carbonaceous matter itself loses $1\frac{1}{4}$ per cent. more at 150° C., yet it is always dried at 100° C.—never at a higher temperature. If charcoal is dried at 150° C.—and I think this temperature would be a safe one—the carbonaceous and organic matters should be dried at the same temperature, otherwise the organic matter soluble in hydrochloric acid, which is a difference quantity, will be returned too low, if not wiped out altogether. Thus in II.,* the organic matter soluble in hydrochloric acid and in water are together 2·02 per cent. and contain 0·33 of nitrogen. By drying the charcoal at 150° C. and the other constituents of the loss on ignition at 100° C., this soluble organic matter would only amount to 2·02 – 1·35 = 0·97 per cent. Were the charcoal dried at 200° C. the soluble organic matter would be reduced to 2·02 – 1·59 = 0·43 per cent., which is too small a quantity to contain 0·33 of nitrogen. In the sample III.,* which contains 1·45 per cent. of soluble organic matter and 0·10 nitrogen, the organic matter would disappear under the same conditions. Until therefore this water question in relation to the other losses on ignition is satisfactorily settled, and we can determine at what temperature water, which is mere moisture, ceases, and water of decomposition begins to be given off, the safest course to pursue in the analysis of charcoal is to dry the charcoal at 100° C., and determine the constituents of the portion lost on ignition at the same temperature.

*** In the first part of this paper, appearing in our last issue, a number of errors unfortunately got overlooked. They were as follows:—

1. On p. 401, line 6 from the bottom, read "difference" for "different."
2. On p. 404, line 12 from the top, read "half-filled" for "half-filtered."
3. On p. 404, line 20 from the top, between "matter" and "thus," insert "The difference between the carbonaceous matter." Line 20 should read as follows: "adhering to the first filter is carbonaceous matter. The difference between the carbonaceous matter thus found and the."
4. On p. 405, line 19 from the top, read "sulphur*ous*" for "sulphur*ic*."

(To be continued.)

A consular report on Mexico (No. 3039) gives some valuable hints and suggestions for improving British trade, and also on the regulations dealing with shipping documents and bills of lading, which are very severe. Those having trade transactions with that country would be wise to make themselves familiar with the necessary conditions.

* See table of analyses of charcoals on preceding page.

DEDUCTION OF FORMULÆ FOR CALCULATION OF CAPACITIES AND HEATING SURFACES OF SINGLE OR MULTIPLE EFFECTS.*

By Edw. P. Eastwick, Jr., C.E., Ph.B.

Continued from Page 394.

Let us look now at the deduction of Jelinek's and Déon's formulæ, and find out, if possible, the reason for the differences in values obtained for the same quantities when calculated by each of the two sets of formulæ.

The fundamental formulæ given by Jelinek are, as previously stated:*

$$Q_x = \frac{F_x a (T_x - \theta_x)}{1115{\cdot}2 - {\cdot}708 T_x} \qquad \text{(b)}$$

$$p_x = \frac{F_x a (T_x - \theta_x)}{1081{\cdot}4 + {\cdot}305\theta_x - (t_x - 32)} \qquad \text{(d)}$$

in which

Q_x = Quantity of heating steam condensed in unit time, lbs.,
p_x = Quantity of water evaporated in body in unit time, lbs.,
F_x = Heating surface of body, sq. ft.,
θ_x = Temperature, Fahr., of liquid boiling in body,
T_x = Temperature, Fahr., of heating steam of body,
t_x = Temperature, Fahr., of liquid entering body,
a = Mean coefficient of heat transmission, or the number of heat units passing through a unit of heating surface from the heating steam to the liquid to be heated for each degree difference in temperature, B.T.U.

The corresponding formulæ given by Déon are:†

When $\theta_x > t_x$:

$$Q_x = \frac{p_x\left[A + B\theta_x - s_x(\theta_x - 32)\right]\left[T_x - \frac{\theta_x + t_x}{2}\right] + (T_x - \theta_x)(\theta_x - t_x) G_x s_x}{\left[T_x - \frac{\theta_x + t_x}{2}\right]\left[A + BT_x - (\theta_x - 32)\right]} \qquad \text{(f)}$$

$$p_x = \frac{F_x D (T_x - \theta_x)\left[T_x - \frac{\theta_x + t_x}{2}\right]\left[A + BT_x - (\theta_x - 32)\right] - (T_x - \theta_x)(\theta_x - t_x) G_x s_x}{\left[T_x - \frac{\theta_x + t_x}{2}\right]\left[A + B\theta_x - s_x(\theta_x - 32)\right]} \qquad \text{(h)}$$

*Owing to a difference of opinion we have had with the Author, it is advisable to point out here that in this paper the decimal is represented by a point placed about the middle (·5). This is the usual method in English practice and it is never placed on the line as appears to be done in some other countries.

† Original letters in formulæ being changed.

When $\theta_x = t_x$:

$$Q_x = \frac{p_x [A + B\theta_x - s_x (\theta_x - 32)]}{A + BT_x - (\theta_x - 32)} \qquad (f_b)$$

$$p_x = \frac{F_x D (T_x - \theta_x) [A + BT_x - (\theta_x - 32)]}{A + B\theta_x - s_x (\theta_x - 32)} \qquad (h_b)$$

When $\theta_x < t_x$:

$$Q_x = \frac{p_x [A + B\theta_x - s_x(\theta_x - 32)] [A + BT_x - (\theta_x - 32)] - (A + B\theta_x)(t_x - \theta_x) G_x s_x}{[A + BT_x - (\theta_x - 32)]^2} \qquad (f_c)$$

$$p_x = \frac{F_x D (T_x - \theta_x) [A + BT_x - (\theta_x - 32)]^2 + (A + B\theta_x)(t_x - \theta_x) G_x s_x}{[A + B\theta_x - (\theta_x - 32)] [A + BT_x - (\theta_x - 32)]} \qquad (h_c)$$

in which

Q_x, p_x, F_x, θ_x, T_x, and t_x represent the same quantities as in formulæ (b) and (d),

$A = 1081{\cdot}4$, $B = 0{\cdot}035$ (Corresponding to English Measure),

s_x = Mean specific heat of liquid in body,

D = Quantity of steam condensed per unit of surface, in unit time, for one degree difference in temperature of heating steam on one side of condensing surface and liquid being heated on the other side, lbs.

Taking up first the formulæ for calculating Q_x, it will be noted, at the outset, that Jelinek gives but one formula, (b), which is applicable under all conditions, while, on the other hand, Déon, apparently, gives three formulæ, one of which is used when the temperature of boiling in the body is greater than the temperature of the liquid entering the body, the second when these temperatures are the same, and the third when conditions of the first case are reversed. As a matter of fact, however, Déon's three formulæ are the same, and only written in a different way. This we have already shown by substituting in formulæ (f), (f_b), and (f_c), the value of p_x, as found by formulæ (h), (h_b), and (h_c) respectively, when all of the formulæ are reduced to the common form:

$$Q_x = F_x D (T_x - \theta_x) \qquad (i)$$

Jelinek's formula, (b), is deduced on the assumption that the latent heat of the steam condensed, or $Q_x (1115{\cdot}2 - {\cdot}708T_x)$, is the heat which is supplied by the steam, and is equivalent to the heat units passing through the heating surface F_x, due to the difference of temperature of the heating steam on one side and the liquid being heated on the other side. This is correct, if the effect of air and other gases mixed with the steam, and the loss of heat from the apparatus is neglected, and the heat units transmitted through the heating surface from the steam to the liquid equal $F_x \times \alpha \times$ (T_x - mean temperature of liquid).* Jelinek considers that the mean difference in temperature between the steam and liquid is $T_x - \theta_x$, and, therefore, the heat

* This assumes that the heating steam remains at constant temperature. The presence of air or other gases in the steam interferes with proper circulation of the steam, and reduces by a constantly varying and indeterminate amount the efficiency of the heating or condensing surface.

transmitted through F_x surface would be $F_x a (T_x - \theta_x)$, hence the equation:

$$Q_x (1115 \cdot 2 - \cdot 708 T_x) = F_x a (T_x - \theta_x)$$

from which

$$Q_x = \frac{F_x a (T_x - \theta_x)}{1115 \cdot 2 - \cdot 708 T_x} \qquad \text{(b)}$$

This is Jelinek's general formula for Q_x, but it is evident that it is correct only when steam is free from air or other gases, all losses of heat are neglected, and the liquid entering a body has the same, or a higher, temperature than the temperature of boiling in the body, for these are the only conditions under which it would be true, or admissible, to say that $T_x - \theta_x$ equals the mean difference in temperature between the heating steam and the liquid being heated. When the liquid enters the body at a higher temperature than the temperature of boiling in that body, an almost instantaneous evaporation takes place, which carries off in the vapour the excess of heat, reducing the temperature of the liquid to that of boiling corresponding to the pressure. In consequence of this the effect of the higher temperature is insignificant, and may be neglected, and, therefore, the mean temperature of the liquid in a body, entering at a temperature higher than the temperature of boiling, may, for all practical purposes, be considered to be the temperature of boiling.

When liquid enters a body at a lower temperature than that of boiling in the body the heat first transmitted from the heating steam to the liquid is used only for bringing up the temperature of the liquid to boiling point, and supplying the loss of heat from the liquid by radiation from the apparatus, &c.; after this all the heat supplied causes evaporation.

If G_x is the quantity of liquid entering the body in unit time, we may assume, for convenience of calculation, that this quantity of liquid is heated to boiling temperature, the required amount of water, p_x, evaporated, and the concentrated liquid remaining discharged from the body before any additional fresh liquid enters the body. This is not strictly in accordance with the actual practical operation of a multiple effect, but the assumption of the intermittent working is permissible, and will not affect the accuracy of the following deductions:—

During the time the liquid is being heated the mean difference in temperature between the heating steam and the liquid is, approximately, and close enough for the present purpose, $T_x - \frac{\theta_x + t_x}{2}$,* and, after the temperature of the liquid is brought up to the temperature of boiling, the difference is $T_x - \theta_x$. Now let qy_x represent the

* The exact value of the mean difference in temperature between a liquid being heated and the heating steam in a case of this kind equals, according to Grashop and E. Hausbrand, $\dfrac{(T_x - t_x) - (T_x - \theta_x)}{\text{Nap. log. } \dfrac{T_x - t_x}{T_x - \theta_x}}$. *Vid.* (Verdampfen, Kondensiren und Kühlen, 2nd Edition, 1900).

quantity of steam condensed, and Fy_x the surface required to heat G_x quantity of liquid from $t_x°$ to boiling temperature ($\theta_x°$), in unit time, and let qz_x represent the quantity of steam condensed, and Fz_x the surface required to evaporate p_x quantity of water, in unit time, when α_x represents the mean coefficient of heat transmission for body of apparatus considered, Σy_x and Σz_x represent the loss of heat from liquid and vapour formed therefrom, and Δy_x and Δz_x represent the loss of heat from heating steam,* during each of the operations, respectively, of heating the liquid to boiling temperature, and evaporating the water, then if it is assumed that the air and other gases contained in the steam are removed to such an extent that the effect of their presence may be neglected, which is true for a properly designed apparatus, provided with adequate means for conveying off the gases, the following equations are true:—

$$qy_x(1115{\cdot}2 - {\cdot}708T_x) = Fy_x\alpha_x\left(T_x - \frac{\theta_x + t_x}{2}\right) + \Delta y_x\dagger \qquad (a_y)$$

$$qz_x(1115{\cdot}2 - {\cdot}708T_x) = Fz_x\alpha_x(T_x - \theta_x) + \Delta z_x \qquad (a_z)$$

from which

$$qy_x = \frac{Fy_x\alpha_x\left(T_x - \frac{\theta_x + t_x}{2}\right) + \Delta y_x}{1115{\cdot}2 - {\cdot}708T_x} \qquad (u)$$

$$qz_x = \frac{Fz_x\alpha_x(T_x - \theta_x) + \Delta z_x}{1115{\cdot}2 - {\cdot}708T_x} \qquad (v)$$

Since $qy_x + qz_x = Q_x$, $Fy_x + Fz_x = F_x$, and letting $\Delta y_x + \Delta z_x = \Delta_x$, we get from formulæ (u) and (v):

$$Q_x (= qy_x + qz_x) = \frac{F_x\alpha_x(T_x - \theta_x) + \frac{Fy_x\alpha_x(\theta_x - t_x)}{2} + \Delta_x}{1115{\cdot}2 - {\cdot}708T_x} \qquad (A_x)$$

During the first operation of heating G_x quantity of liquid from $t_x°$ to $\theta_x°$ temperature the heat transmitted from the steam to the liquid is not only the heat units required to raise the temperature of the liquid this amount, which, if s_x represented the specific heat of the liquid, equals $G_xs_x(\theta_x - t_x)$, but also to supply the heat units, Σy_x, lost by the liquid, due to radiation, &c., hence from (a_y) the equation follows:—

$$qy_x(1115{\cdot}2 - {\cdot}708T_x) = Fy_x\alpha_x\left(T_x - \frac{\theta_x + t_x}{2}\right) + \Delta y_x = G_xs_x(\theta_x - t_x) + \Sigma y_x + \Delta y_x$$

and from this equation:

$$Fy_x = \frac{G_xs_x(\theta_x - t_x) + \Sigma y_x}{\alpha_x\left(T_x - \frac{\theta_x + t_x}{2}\right)} \qquad (w)$$

* Δy_x and Δz_x represent the heat units lost by the heating steam due to radiation, &c., from side of steam chamber, owing to which a certain amount of steam is condensed.

† As qy_x is the steam required to heat the liquid only, the loss of heat in gases removed does not enter equation.

Substituting this value of Fy_x in formula (A_x) gives:

$$Q_x = \frac{F_x a_x(T_x - \theta_x) + \dfrac{G_x s_x(\theta_x - t_x)^2}{2\left(T_x - \dfrac{\theta_x + t_x}{2}\right)} + \dfrac{\Sigma y_x(\theta_x - t_x)}{2\left(T_x - \dfrac{\theta_x + t_x}{2}\right)} + \Delta_x}{1115{\cdot}2 - {\cdot}708T_x} \quad (A_a)$$

Formula (A_a) is a correct general formula for calculating the value of Q_x under all conditions, and takes the place of Jelinek's formula, (b).

When the temperature of the liquid is equal to the temperature of boiling in the body $\dfrac{G_x s_x(\theta_x - t_x)^2}{2\left(T_x - \dfrac{\theta_x + t_x}{2}\right)}$ and $\dfrac{\Sigma y_x(\theta_x - t_x)}{2\left(T_x - \dfrac{\theta_x + t_x}{2}\right)}$ both equal 0.

$\dfrac{G_x s_x(\theta_x - t_x)^2}{2\left(T_x - \dfrac{\theta_x + t_x}{2}\right)}$ and $\dfrac{\Sigma y_x(\theta_x - t_x)}{2\left(T_x - \dfrac{\theta_x + t_x}{2}\right)}$ likewise equal 0, when $\theta_x < t_x$, for, as previously explained, in this case $T_x - \dfrac{\theta_x + t_x}{2}$ may be considered to equal $T_x - \theta_x$, and, therefore:

$$\frac{G_x s_x(\theta_x - t_x)^2}{2\left(T_x - \dfrac{\theta_x + t_x}{2}\right)} = G_x s_x(\theta_x - t_x) - G_x s_x(\theta_x - t_x)\frac{T_x - \theta_x}{T_x - \dfrac{\theta_x + t_x}{2}} = 0 \quad (w_b)$$

and

$$\frac{\Sigma y_x(\theta_x - t_x)}{2\left(T_x - \dfrac{\theta_x + t_x}{2}\right)} = \Sigma y_x\left(1 - \frac{T_x - \theta_x}{T_x - \dfrac{\theta_x + t_x}{2}}\right) = 0 \quad (w_c)$$

Formula (A_a) then becomes

$$Q_x = \frac{F_x a_x(T_x - \theta_x) + \Delta_x}{1115{\cdot}2 - {\cdot}708T_x} \quad (A_b) \text{ and } (A_c)^*$$

and when Δ_x is neglected, or equals 0, and a is substituted for a_x:

$$Q_x = \frac{F_x a(T_x - \theta_x)}{1115{\cdot}2 - {\cdot}708T_x} \quad (b)$$

This is the formula given by Jelinek for all conditions, but its applicability is, as we have now seen, restricted to steam free from air and other gases, and the case when the value of θ_x is equal to, or greater than, t_x, and loss of heat is neglected. Under any other conditions the results obtained by this formula would not be accurate, and in place of it formula (A_a) should be used.

Taking up next Jelinek's formula (d) for the evaporation, p_x, in a body, it would seem that this formula has been deduced on the assumption that the total amount of heat transmitted to the liquid from the heating steam equals the "total heat"† of the quantity of

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* When $\theta_x = t_x$, or $\theta_x < t_x$, formula (w) gives a value of 0 for Fy_x, and substituting this in formula (A_x) we obtain formula (A_b). In the first case (w) gives $Fy_x = \dfrac{\Sigma y_x}{a_x(T_x - \theta_x)}$ but Σy_x is 0, hence $Fy_x = 0$. In the second case (w) gives $Fy_x = \dfrac{G_x s_x(\theta_x - t_x)}{a_x\left(T_x - s_x\dfrac{\theta_x + t_x}{2}\right)} + \dfrac{\Sigma y_x}{a_x\left(T_x - \dfrac{\theta_x + t_x}{2}\right)} = 0$. *Vid.* (w_c).

† Total heat is the units of heat necessary to convert a unit weight of liquid at 32° F. to vapour of given temperature.

vapour generated in the body, minus the original heat in the same quantity of liquid above 32° as it enters the body. Considering steam free from air and other gases, and neglecting loss of heat, this, however, is only correct when p_x is the total quantity of liquid which enters the body, or when the temperature of the liquid is the same as the temperature of boiling in the body, and the specific heat of the liquid the same as water, which Jelinek assumes. The difference would then be expressed by $p_x[1081{\cdot}4 + {\cdot}305\theta_x - (t_x - 32)]$.* The heat transmitted from the steam by the heating surface has been considered to equal $F_x a(T_x - \theta_x)$, which, as previously shown, is correct only when the juice entering the body has the same, or a higher, temperature than the temperature of boiling in the body. According to Jelinek, the equation follows:—

$$p_x[1081{\cdot}4 + {\cdot}305\theta_x - (t_x - 32)] = F_x a(t_x - \theta_x)$$

from which,

$$p_x = \frac{F_x a(t_x - \theta_x)}{1081{\cdot}4 + {\cdot}305\theta_x - (t_x - 32)} \qquad \text{(d)}$$

and (d) is the formula given by Jelinek for calculating p_x under all conditions, but which, as will be seen more clearly later, is accurate only in the case when the temperature of the liquid entering the body is the same as the temperature of boiling in the body, or when the temperature of the liquid entering the body is higher than the temperature of boiling in the body, and, in addition, all of the liquid entering the body is evaporated into steam free from air or other gases, loss of heat being neglected, and specific heat assumed to be 1. This is not in accordance with the working of a multiple effect, and, moreover, the formula could apply only to the boiling of pure water, containing no solid matter, not a sugar solution, which would leave a residue.

As a matter of fact the heat transmitted from the heating steam to the liquid in a body of a multiple effect, under all conditions, is equal to the total heat of the vapour of evaporation, which is $p_x(1081{\cdot}4 + {\cdot}305\theta_x) + d_x$, if d_x represents the units of heat contained in the air and other gases mixed with the steam, plus the heat units in the remaining liquid, $(G_x - p_x)\,s_x\theta_x$, minus the heat units above 32° contained in the entire amount of liquid entering the body $G_x s_x(t_x - 32)$,† and if to this is added the total loss of heat in steam chamber, Δ_x, and loss of heat in vapour chamber, $\Sigma y_x + \Sigma z_x$, which we will represent by Σ_x, and includes all losses except d_x, the sum will equal the total amount of heat given up by the heating steam condensed, $Q_x(1115{\cdot}2 - {\cdot}708T_x)$, which according to formula (A_a) equals:

* This assumes the specific heat of the liquid to be 1, or the same as water, since the heat contained in it above 32° is $p_x(t_x - 32) \times$ specific heat.

† s_x is the average specific heat of the juice while in body. To be more accurate the exact value of the specific heat of the liquid at different conditions of concentration and temperature should be taken.

$$F_x a_x(T_x - \theta_x) + \frac{G_x s_x(\theta_x - t_x)^2}{2\left(T_x - \frac{\theta_x + t_x}{2}\right)} + \frac{\Sigma y_x(\theta_x - t_x)}{2\left(T_x - \frac{\theta_x + t_x}{2}\right)} + \Delta_x$$

hence the equation:

$$p_x(1081{\cdot}4 + {\cdot}305\theta_x) + d_x + (G_x - p_x)s_x(\theta_x - 32) - G_x s_x(t_x - 32) + \Delta_x + \Sigma_x = Q_x(1115{\cdot}2 - {\cdot}708T_x) =$$

$$F_x a_x(T_x - \theta_x) + \frac{G_x s_x(\theta_x - t_x)^2}{2\left(T_x - \frac{\theta_x + t_x}{2}\right)} + \frac{\Sigma y_x(\theta_x - t_x)}{2\left(T_x - \frac{\theta_x + t_x}{2}\right)} + \Delta_x \qquad (x)$$

from which

$$p_x = \frac{F_x a_x(T_x - \theta_x) + G_x s_x\left[\frac{(\theta_x - t_x)^2}{2\left(T_x - \frac{\theta_x + t_x}{2}\right)} - \theta_x + t_x\right] - \Sigma_x - d_x + \frac{\Sigma y_x(\theta_x - t_x)}{2\left(T_x - \frac{\theta_x + t_x}{2}\right)}}{1081{\cdot}4 + 305\theta_x - s_x(\theta_x - 32)} \qquad (y)$$

but

$$G_x s_x\left[\frac{(\theta_x - t_x)^2}{2\left(T_x - \frac{\theta_x + t_x}{2}\right)} - \theta_x + t_x\right] = - G_x s_x(\theta_x - t_x)\left[\frac{T_x - \theta_x}{T_x - \frac{\theta_x + t_x}{2}}\right]^*$$

and substituting this last value in (y):

$$p_x = \frac{F_x a_x(T_x - \theta_x) - G_x s_x(\theta_x - t_x)\left[\frac{T_x - \theta_x}{T_x - \frac{\theta_x + t_x}{2}}\right] - \Sigma_x - d_x + \frac{\Sigma y_x(\theta_x - t_x)}{2\left(T_x - \frac{\theta_x + t_x}{2}\right)}}{1115{\cdot}2 - {\cdot}708\theta_x}{}^{\dagger} \qquad (B_x)$$

Since both Σ_x and d_x represent losses of heat in the vapour chamber it will simplify the above formula, and those deduced hereinafter, if we will let Σ_x represent the total sum of all the losses of heat in the vapour chamber including d_x, when formula (B_x) becomes:

$$p_x = \frac{F_x a_x(T_x - \theta_x) - G_x s_x(\theta_x - t_x)\left[\frac{T_x - \theta_x}{T_x - \frac{\theta_x + t_x}{2}}\right] - \Sigma_x + \frac{\Sigma y_x(\theta_x - t_x)}{2\left(T_x - \frac{\theta_x + t_x}{2}\right)}}{1115{\cdot}2 - {\cdot}708\theta_x} \qquad (B_a)$$

Formula (B_a) is a correct general formula for calculating the value of p_x under all conditions, and takes the place of Jelinek's formula (d).

We have previously determined that $\frac{T_x - \theta_x}{T_x - \frac{\theta_x + t_x}{2}}$ equals 1, and $\frac{\Sigma y_x(\theta_x - t_x)}{2\left(T_x - \frac{\theta_x + t_x}{2}\right)}$ equals 0, when $\theta_x < t_x$. Substituting the values in (B_a) the formula then becomes:

$$p_x = \frac{F_x a_x(T_x - \theta_x) + G_x s_x(t_x - \theta_x) - \Sigma_x}{1115{\cdot}2 - {\cdot}708\theta_x} \qquad (B_c)$$

When the temperature of the liquid entering a body is the same as the temperature of boiling in the body, or $\theta_x = t_x$, we get from formula (B_a) or (B_c):

$$p_x = \frac{F_x a_x(T_x - \theta_x) - \Sigma_x}{1081{\cdot}4 + {\cdot}305\theta_x - s_x(t_x - 32)} = \frac{F_x a_x(T_x - \theta_x)}{1115{\cdot}2 - {\cdot}708\theta_x} \qquad (B_b)$$

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* *Vid.* (Wb). † $1081{\cdot}4 + {\cdot}305\theta_x - s_x(\theta_x - 32) = 1115{\cdot}2 - {\cdot}708\theta_x$.

which becomes Jelinek's formula (d) when the vapour is steam free from air and other gases, the loss of heat from liquid and vapour, Σ_x, is neglected, a is substituted for a_x, and s_x equals 1.* Formula (d) is also obtained by substituting p_x for G_x in formula (B_c), but not when p_x is substituted for G_x in formula (B_a), and we thus see, as already stated, that Jelinek's formula is applicable for calculating the evaporation in the body of a multiple effect only when vapour evaporated is free from air or other gases, all losses of heat are neglected, specific heat equals 1, and under special conditions, viz.: (1) when the temperature of the liquid entering the body is the same as the temperature of boiling in the body, or (2) when the temperature of the liquid entering the body is higher than the temperature of boiling in the body, and in addition all the liquid entering the body is evaporated in the body, which latter would only be possible when the liquid was water.

Let us now examine into Déon's formulæ, considering first his formula for calculating Q_x, when $\theta_x > t_x$, which is formula (f), and giving the proper values to A and B, it becomes:

$$Q_x = \frac{p_x\left[1081{\cdot}4 + {\cdot}305\theta_x - s_x(\theta_x - 32)\right]\left(T_x - \frac{\theta_x + t_x}{2}\right) + (T_x - \theta_x)(\theta_x - t_x)G_x s_x}{\left[T_x - \frac{\theta_x + t_x}{2}\right]\left[1081{\cdot}4 + {\cdot}305T_x - (\theta_x - 32)\right]} \qquad \text{(f)}$$

This formula has been deduced as follows:—

Letting qy_x represent the quantity of heating steam condensed to heat G_x quantity of liquid from $t_x°$ to $\theta_x°$, and qz_x the quantity of steam condensed in evaporating p_x quantity of water, Déon then gives the equations, which, when expressed in English Measure, are:

$$[1081{\cdot}4 + {\cdot}305T_x - (\theta_x - 32)]\,qy_x = G_x s_x(\theta_x - t_x)\dagger$$

$$\left\{\begin{array}{l}[1081{\cdot}4 + {\cdot}305T_x - (\theta_x - 32)]\,qz_x + G_x s_x(\theta_x - 32) = \\ \quad (1081{\cdot}4 + {\cdot}305\theta_x)\,p_x + (G_x - p_x)\,s_x(\theta_x - 32)\end{array}\right\} \qquad (f_a)$$

from which

$$qy_x = \frac{G_x s_x(\theta_x - t_x)}{1081{\cdot}4 + {\cdot}305T_x - (\theta_x - 32)}$$

$$qz_x = \frac{p_x[1081{\cdot}4 + {\cdot}305\theta_x - s_x(\theta_x - 32)]}{1081{\cdot}4 + {\cdot}305T_x - (\theta_x - 32)}$$

and if Q_x represents the total steam condensed in unit time in evaporating p_x quantity of water, which is assumed to be free of air or other gases, from a liquid entering a body of a multiple effect at $t_x°$ temperature, and loss of heat is neglected, then, apparently:

$$Q_x (= qy_x + qz_x) = \frac{p_x[1081{\cdot}4 + {\cdot}305\theta_x - s_x(\theta_x - 32)] + G_x s_x(\theta_x - t_x)}{1081{\cdot}4 + {\cdot}305T_x - (\theta_x - 32)} \qquad (A_y)$$

But Déon states that formula (A_y) is not complete, because the effect of relative time required for heating the liquid to boiling temperature,

* $s_x = 1$ in Jelinek's formula, and since $\theta_x = t_x$, and $\Sigma_x = 0$, then

$$\frac{F_x a_x(T_x - \theta_x) - \Sigma_x}{1081{\cdot}4 + {\cdot}305\theta_x - s_x(\theta_x - 32)} = \frac{F_x a_x(T_x - \theta_x)}{1081{\cdot}4 + {\cdot}305\theta_x - (t_x - 32)}$$

† The manner of writing the equations differs slightly from the original.

and then for evaporation, has not been considered, and he states that when this effect is taken into account, the following is true:

$$Q_x = qz_x + \frac{T_x - \theta_x}{T_x - \frac{\theta_x + t_x}{2}} \times qy_x \qquad (z)$$

This is not clear, and, in fact, appears incorrect, for, if in equations (f_a) G_x represents the quantity of liquid entering a body in unit time, and p_x represents the quantity of water evaporated in the body in unit time, the quantity of steam condensed in unit time will be $Q_x = qy_x + qz_x$. However, substituting the values of qy_x and qz_x in (z) he obtains:

$$Q_x = \frac{p_x\left[1081{\cdot}4 + {\cdot}305\theta_x - s_x(\theta_x - 32)\right]\left[T_x - \frac{\theta_x + t_x}{2}\right] + (T_x - \theta_x)(\theta_x - t_x)G_x s_x}{\left[T_x - \frac{\theta_x + t_x}{2}\right]\left[1081{\cdot}4 + {\cdot}305T_x - (\theta_x - 32)\right]} \qquad (f)$$

Formula (f) is given by Déon for calculating Q_x for $\theta_x > t_x$, when loss of heat from apparatus is neglected.

To obtain formula (f) Déon has assumed that the heat furnished by the steam is the total heat of the steam, minus the heat units corresponding to the temperature of boiling in the body above 32°, or, in other words, that the steam not only gives up its latent heat, but the water of condensation also parts with heat enough to reduce it to the temperature of boiling in the body. This is not correct in the practical working of a multiple effect, for the water of condensation is in contact with the steam until it is removed, and for efficient working the removal of the water of condensation must be such as not to allow of any accumulations. The heat given off by the heating steam under these conditions is, as before stated, the latent heat of the steam condensed, and, therefore, since $1081{\cdot}4 + {\cdot}305T_x - s_x(T_x - 32) = 1115{\cdot}2 - {\cdot}708T_x$ is the latent heat of steam of $T_x°$ temperature, Fahr., Déon's equations (f_a), to have been correct, and to have taken into account the air and other gases contained in the vapour evaporated, and the loss of heat from apparatus, should have been:

$$(1115{\cdot}2 - {\cdot}708T_x)\,qy_x = G_x s_x(\theta_x - t_x) + \Delta y_x + \Sigma y_x$$

$$\left\{\begin{array}{c}(1115{\cdot}2 - {\cdot}708T_x)\,qz_x + G_x s_x(\theta_x - 32) = \\ (1081{\cdot}4 + {\cdot}305\theta_x)\,p_x + (G_x - p_x)\,s_x(\theta_x - 32) + \Delta z_x + \Sigma z_x\end{array}\right\} \qquad (f_b)$$

Δy_x in the above equations represents the heat lost by the heating steam, and Σy_x the heat lost by the liquid being heated, during the time it is being heated from $t_x°$ to boiling temperature, and Δz_x and Σz_x represent similar losses of heat by the steam and liquid, or vapour, during the time required for evaporation. $\Delta_x = \Delta y_x + \Delta z_x$, and $\Sigma_x = \Sigma y_x + \Sigma z_x$, which includes the units of heat contained in the air and other gases mixed with the vapour evaporated.

Equations (f_b) would then mean that the heat given off by the heating steam condensed in evaporating p_x quantity of water from

boiling temperature, plus the heat in the original quantity of liquid above 32°, is equivalent to the total heat of the vapour evaporated, plus the heat above 32° in the liquid remaining in the body after evaporation, and the total loss of heat from the apparatus.

From the last two equations:

$$qy_x = \frac{G_x s_x(\theta_x - t_x) + \Delta y_x + \Sigma y_x}{1115{\cdot}2 - {\cdot}708T_x}$$

$$qz_x = \frac{p_x(1115{\cdot}2 - {\cdot}708\theta_x) + \Delta z_x + \Sigma z_x{}^{*}}{1115{\cdot}2 - {\cdot}708T_x}$$

and adding qy_x and qz_x, remembering that $\Delta y_x + \Delta z_x = \Delta_x$ and $\Sigma y_x + \Sigma z_x = \Sigma_x$:

$$Q_x(= qy_x + qz_x) = \frac{p_x(1115{\cdot}2 - {\cdot}708\theta_x) + G_x s_x(\theta_x - t_x) + \Delta_x + \Sigma_x}{1115{\cdot}2 - {\cdot}708T_x} \quad (AA_a)$$

Formula (AA_a) is a correct general formula for calculating the value of Q_x under all conditions, and takes the place of Déon's formulæ (f), (f_b), and (f_c).

When $\theta_x = t_x$ (AA_a) becomes:

$$Q_x = \frac{p_x(1115{\cdot}2 - {\cdot}708\theta_x) + \Delta z_x + \Sigma z_x{}^{\dagger}}{1115{\cdot}2 - 708T_x} \quad (AA_b)$$

and when $\theta_x < t_x$:

$$Q_x = \frac{p_x(1115{\cdot}2 - {\cdot}708\theta_x) - G_x s_x(t_x - \theta_x) + \Delta z_x + \Sigma z_x{}^{\ddagger}}{1115{\cdot}2 - {\cdot}708T_x} \quad (AA_c)$$

If D represents the quantity of steam condensed in a multiple effect per unit of surface, in unit time, for one degree difference of temperature, Déon further states that then—

$$F_x = \frac{Q_x}{D(T_x - \theta_x)}$$

and hence from (f):

$$F_x = \frac{p_x\left[1081{\cdot}4 + {\cdot}305\theta_x - s_x(\theta_x - 32)\right]\left[T_x - \frac{\theta_x + t_x}{2}\right] + (T_x - \theta_x)(\theta_x - t_x)G_x s_x}{D(T_x - \theta_x)\left[T_x - \frac{\theta_x + t_x}{2}\right]\left[1081{\cdot}4 + {\cdot}305T_x - (\theta_x - 32)\right]} \quad (g)$$

from which:

$$p_x = \frac{F_x D(T_x - \theta_x)\left[1081{\cdot}4 + {\cdot}305\theta_x - (\theta_x - 32)\right]\left[T_x - \frac{\theta_x + t_x}{2}\right] - (T_x - \theta_x)(\theta_x - t_x)G_x s_x}{\left[1081{\cdot}4 + {\cdot}305\theta_x - s_x(\theta_x - 32)\right]\left[T_x - \frac{\theta_x + t_x}{2}\right]} \quad (h)$$

Formulæ (g) and (h) are given by Déon for calculating F_x and p_x when $\theta_x > t_x$, and, if formula (f) is incorrect, then formulæ (g) and (h) must also be. It likewise follows that Déon's formulæ (g_b) and (h_b) for calculating F_x and p_x when $\theta_x = t_x$ are incorrect.

* Since $1081{\cdot}4 + {\cdot}305\theta_x - s_x(\theta_x - 32) = 1115{\cdot}2 - {\cdot}708\theta_x$.

† Substituting in formula (AA_a) the value of p_x, given by formula (B_a), and referring to formula (W_b), it will be found that formula (AA_a) may be put in the same form as formula (A_a).

‡ In this case $\Delta_x = \Delta z_x$ and $\Sigma_x = \Sigma z_x$, since Δy_x and Σy_x are both 0.

The deduction of formula (f_e), as given by Déon, is briefly as follows:—The heat given out by G_x quantity of liquid, in cooling from t_x° to θ_x°, is $G_x s_x(t_x - \theta_x)$, which, he states, corresponds to the evaporation of $G_x s_x \frac{t_x - \theta_x}{1081{\cdot}4 + {\cdot}305T_x - (\theta_x - 32)}$ quantity of water, leaving to be evaporated by the steam only $p_x - G_x s_x \frac{t_x - \theta_x}{1081{\cdot}4 + {\cdot}305T_x - (\theta_x - 32)}$ quantity of water of θ_x° temperature, which will require $(1081{\cdot}4 + {\cdot}305T_x) \times \left(p_x - G_x s_x \frac{t_x - \theta_x}{1081{\cdot}4 + {\cdot}305T_x - (\theta_x - 32)}\right)$ units of heat. If, therefore, Q_x is the amount of steam required to be condensed in order to evaporate $p_x - G_x s_x \frac{t_x - \theta_x}{1081{\cdot}4 + {\cdot}305T_x - (\theta_x - 32)}$ quantity of water from θ_x° temperature, the heat given out by this steam, according to Déon, is $Q_x[1081{\cdot}4 + {\cdot}305T_x - (\theta_x - 32)]$, and hence the equation:

$$\left.\begin{array}{l} Q_x[1081{\cdot}4+{\cdot}305T_x - (\theta_x - 32)] + G_x s_x(\theta_x - 32) = 1081{\cdot}4 + {\cdot}305\theta_x) \times \\ \left[p_x - G_x s_x \frac{t_x - \theta_x}{1081{\cdot}4 + {\cdot}305T_x - (\theta_x - 32)}\right] + (G_x - p_x)\, s_x(\theta_x - 32) \end{array}\right\} \quad (z_1)$$

from which:

$$Q_x = \left\{\begin{array}{c} \frac{p_x[1081{\cdot}4 + {\cdot}305\theta_x - s_x(\theta_x - 32)]\,[1081{\cdot}4 + {\cdot}305T_x - (\theta_x - 32)]}{[1081{\cdot}4 + {\cdot}305T_x - (\theta_x - 32)]^2} - \\ \frac{(1081{\cdot}4 + {\cdot}305\theta_x)\,(t_x - \theta_x)\, G_x s_x}{[1081{\cdot}4 + {\cdot}305T_x - (\theta_x - 32)]^2} \end{array}\right\} \quad (f_e)$$

The errors in the deduction of formula (f_e) are evident. In the first place, the quantity of water evaporated by $G_x s_x(t_x - \theta_x)$ units of heat is not $G_x s_x \frac{t_x - \theta_x}{1081{\cdot}4 + {\cdot}305T_x - (\theta_x - 32)}$, but equals $G_x s_x \frac{t_x - \theta_x}{1081{\cdot}4 + {\cdot}305\theta_x}$, and, secondly, the heat given out by the condensation of Q_x quantity of steam of T_x° temperature is not $Q_x[1081{\cdot}4 + {\cdot}305T_x - (\theta_x - 32)]$, but equals $Q_x(1115{\cdot}2 - 708T_x)$. Therefore, in place of (z_1), the correct equation, taking into account all losses of heat, would be:

$$Q_x(1115{\cdot}2 - {\cdot}708T_x) + G_x s_x(\theta_x - 32) =$$
$$(1081{\cdot}4 + {\cdot}305\theta_x)\left[p_x - G_x s_x \frac{t_x - \theta_x}{1081{\cdot}4 + {\cdot}305\theta_x}\right] + (G_x - p_x)s_x(\theta_x - 32) + \Delta z_x + \Sigma z_x$$

from which

$$Q_x = \frac{p_x(1115{\cdot}2 - {\cdot}708\theta_x) - G_x s_x(t_x - \theta_x) + \Delta z_x + \Sigma z_x}{1115{\cdot}2 - {\cdot}708T_x} \quad (AA_e)$$

This is formula (AA_e), which is a special condition of formula (AA_a) previously deduced.

Formulæ (g_e) and (h_e) being derived from (f_e), it follows that if one is incorrect all must be.

In pointing out above the errors in Déon's formulæ, the deductions of the formulæ, as given by him, have been more or less closely followed, but these errors may be more briefly shown. We have seen that Déon's three formulæ for Q_x, for the conditions $\theta_x > t_x$, $\theta_x = t_x$,

and $\theta_x < t_x$, may all be reduced to the same form, given by formula (i), which is:

$$Q_x = F_x D(T_x - \theta_x)$$

and from this:

$$F_x = \frac{\theta_x}{D(T_x - \theta_x)}$$

According to formula (k), when D is replaced by its equivalent in terms of a, formula (i) becomes—

$$Q_x = \frac{F_x a(T_x - \theta_x)}{1081{\cdot}4 + {\cdot}305T_x - (\theta_x - 32)}$$

from which would follow the equation:

$$Q_x[1081{\cdot}4 + {\cdot}305T_x - (\theta_x - 32)] = F_x a(T_x - \theta_x)$$

and this equation would not be true unless the water of condensation of the steam were reduced to the temperature of boiling in the body (which is not the case), and $T_x - \theta_x$ represented the mean difference between the temperature of the heating steam and the temperature of boiling in the body, which would be true only when θ_x equaled, or was greater than, t_x. Q_x and F_x, as determined by formulæ (i) and (k), would, therefore, be incorrect, and hence all of Déon's formulæ, from which formula (i) is derived, would be incorrect.

(To be continued.)

ERRATA IN FIRST PART OF PAPER (IN AUGUST *I. S. J.*).

On page 388 a bracket in formulæ (f_e) and (g_e) has been improperly placed, and the formulæ should read as follows:—

$$Q_x = \frac{p_x[A+B\theta_x - s_x(\theta_x - 32)][A+BT_x - (\theta_x - 32)] - (A+B\theta_x)(t_x - \theta_x)G_x s_x}{[A + BT_x - (\theta_x - 32)]^2} \quad (f_e)$$

$$F_x = \frac{p_x[A+B\theta_x - s_x(\theta_x - 32)][A+BT_x - (\theta_x - 32)] - (A+B\theta_x)(t_x - \theta_x)G_x s_x}{D(T_x - \theta_x)[A + BT_x - (\theta_x - 32)]^2} \quad (g_e)$$

On page 393 equation (5) should have a plus sign instead of a minus before $\cdot 022G_1$ and should read $345{\cdot}02 + {\cdot}022G_1$. (5)

The same change should also be made in formula (6) on same page, which should read:

$$G_1 = \frac{(357{\cdot}17 - {\cdot}0248G_1) + (345{\cdot}02 + {\cdot}022G_1)}{1 - \frac{12}{54{\cdot}3}} = 898{\cdot}06 \quad (6)$$

NOTES ON PHOSPHATE MANURES.

By H. H. COUSINS.

Apart from the material question of cost, I have always advocated that planters would be well-advised to avoid the complete fertiliser and the special manure of commerce and to purchase the special ingredients required at current market rates.

Our experience in the purchase of fertilisers for the Manurial Experiments of the Board of Agriculture indicate that there is a saving of quite 25% in cost, apart from the special advantages arising from adjusting a manurial mixture to the needs of particular soils and crops.

My chief objection to the ordinary "complete" manure of commerce lies in the fact that there are three types of phosphatic fertilisers, each peculiarly suited to a particular type of soil. It is quite possible to use each of these forms of phosphoric acid without any reasonable probability of any benefit and a possibility of a depression in the resulting crop. For example: basic slag is frequently absolutely inoperative on calcareous soils, while superphosphate may result in detriment to the crop if applied to soils deficient in carbonate of lime. Again there are some soils, representing the lighter lands of our fertile alluvial tracts in Jamaica, where basic slag would be inoperative, superphosphate injurious, and an intermediate or mixed phosphate be the form best adopted to the nature of the soil.

To use a "complete" manure, containing, in the majority of cases, acid phosphates, indiscriminately on all our Jamaica soils is, to my mind, a chemical absurdity.

Before purchasing manures, planters would do well to consult the chemist, and avoid paying too high a price and the possibility of getting an unsuitable mixture.

On many soils in Jamaica phosphates are quite unnecessary. Analyses show that most of our good land is very rich indeed in this ingredient, and that, when exhaustion takes place in course of time, fertilisers supplying nitrogen and potash only should suffice to maintain the standard of fertility in these cases.

Appended are some data as to phosphatic fertilisers recently imported into Jamaica, which may serve to guide planters as to a wise selection.

PHOSPHATE FERTILISERS.

	1. Basic Slag. A.	2. Basic Slag. B.	3. Basic Super-phosphate.	4. Mixed Phosphate.
	Per cent.	Per cent.	Per cent.	Per cent.
Total phosphoric acid ..	16·34	17·29	13·89	18·51
Equal to phosphate of lime	35·67	37·74	30·32	40·41
Citrate soluble—				
Phosphoric acid	9·17	13·52	11·9	13·84
Equal to phosphate of lime.	20·01	29·50	25·97	30·22
Percentage soluble	56·1	78·2	85·6	74·8
Water soluble—				
Phosphoric Acid	Nil.	Nil.	Minute trace	3·35
Equal to phosphate of lime.	Nil.	Nil.	Do.	7·31
Citrate insoluble—				
Phosphoric acid	7·17	3·77	1·99	4·67
Equal to phosphate of lime.	18·66	8·24	4·35	10·19
Cost per ton delivered in Kingston..	£ s. d. 3 1 0	£ s. d. 3 3 0	£ s. d. 4 0 0	£ s. d. 4 0 0

Observations.

For clay soils deficient in lime, and all of the strong retentive lands which may need phosphates, basic slag is the best form. It is advisable to apply it alone and early. It must not be mixed with manure containing ammonia. Dose, 2 to 20 cwt. per acre, according to the crop and the object in view. Its action spreads over at least two years.

No. 1 is a basic slag purchased shrewdly as to price, but really a dear or inferior article owing to low standard of phosphates and very poor solubility (56%). This was bought by a banana planter for use on a stiff soil deficient in available phosphoric acid. For 2s. per ton more he might have obtained No. 2 slag as used by the Board of Agriculture.

This was Albert's slag of high grade in fineness showing 2% more phosphate and a solubility nearly 50% greater than that of No. 1. In buying basic slag a guarantee of "fineness" should be obtained of at least 80%. For Jamaica the highest grade is really the cheapest owing to the cost of freight (18s. per ton).

Basic Superphosphate.

This is a patented article which has just been placed on the market. It is by no means a novelty and the patent rights must be doubtful since we happen to know of a firm who prepared the identical article some years ago and gave it up as unsatisfactory in practice.

The name of the article is not in its favour since it is not "basic" and is not "superphosphate." It is prepared by treating superphosphate with lime; thereby destroying the special value of the superphosphate—its solubility in water—and producing a product that we are convinced is of necessity more expensive than other forms of reverted phosphate and is by no means a basic phosphate with the special chemical advantages of basic slag. A large banana planter was induced to buy a large quantity of this article under the impression that it was similar to and better than basic slag. I estimate a loss to the purchaser of about £200 on this transaction and mention this case to convince planters that the opinion of the chemist in such matters is freely available and may avoid the purchase of the wrong manure at the wrong price.

Superphosphate is undoubtedly the best phosphate for use on medium to light soils containing adequate carbonate of lime. A contract with a firm in Glasgow has just been made per the Crown Agents for a grade of 30% soluble phosphate f.o.b. Bristol, in double bags, at £2 10s. per ton. This firm's quotations were the most favourable of a large number who were asked to quote prices for delivery in April of chemical manures for the Experiments of the Board.

Mixed Phosphate (No. 4) is an intimate mixture of three parts superphosphate and two parts steamed bone flour and is especially

suitable for the majority of light, alluvial soils and those deficient in carbonate of lime.

Its value compared with basic superphosphate shows that, for the same price in Jamaica, we obtain ⅓ more phosphate, ¼ more citrate soluble phosphate and over 7% of water soluble phosphate in addition, in "mixed phosphate" as compared with the consignment of basic superphosphate quoted. Steamed bone flour to contain 65% of phosphates and 2% nitrogen was purchased for the Department at £4 f.o.b. in 1901, at £4 10s. in 1902, and at £4 14s. for the current month.

I recommend the use of mixed phosphate rather than steamed bone flour alone. Banana planters should find this mixture with ⅕ part sulphate of ammonia a useful top dressing on soils in need of manurial assistance. In some cases the ammonia should be supplemented with an equal quantity of 95% sulphate of potash and the mixture applied at the rate of 4 to 8 cwt. per acre.—(*Bull. Dept. of Agriculture, Jamaica.*)

LEVAN: A NEW BACTERIAL GUM FROM SUGAR.*

By R. GREIG-SMITH, M.Sc., AND THOS. STEEL, F.L.S., F.C.S.

In the course of the manufacture of raw sugar from the juice of the sugar cane it sometimes happens, without any apparent cause, that the juice becomes viscous. The result is that the manipulation of the juice is rendered more difficult, and, what is of greater importance, commercially, considerable reduction is caused not only in the yield, but also in the quality of the finished sugar.

From samples of such viscous sugar-cane juice, there was separated by one of us an organism, *Bacillus levaniformans*, sp. nov., which, when cultivated in suitable solutions, has the power of transforming saccharose into a gum which we have named levan, and a mixture of reducing sugars.

Separate papers have been contributed by us to the Linnean Society of New South Wales, and in its Proceedings (1901, Part IV.), the character of the bacillus, its action upon various sugars, the rate of fermentation, &c., are treated at length.

In this paper we have elaborated and combined our data connected with the growth of the organism and of the chemistry of its action on saccharose.

The viscosity may occur in the cane juice—the immediate product of the crushed cane—or it may develop at any stage in the manufacture of the raw sugar, especially if the juice or syrup be allowed to cool, or to stand for any length of time. Experience has shown that the only practicable way to minimise the trouble is to complete the crystallization of the sugar as quickly as possible.

* From Journ. Soc. Chem. Industry.

The cause of the formation of the gum has hitherto not been definitely known. It should here be mentioned that the body under consideration is absolutely distinct from the gum existing in sugar cane affected by the well-known "gumming" or "gummosis" disease. In cane so affected the fibro-vascular vessels of the stalk are found to be plugged with a viscid gum, for which the name vasculin has been proposed by Cobb (Agric. Gaz., N.S. Wales, 1893, 777). This substance, and the nature of its associated bacillus, are at present under investigation by us.

From the viscous juice mentioned at the beginning of this paper, which was obtained from one of the New South Wales mills of the Colonial Sugar Refining Company, Ltd., several organisms were separated, and after various cultural trials, one was found, which, when grown in a Petri dish on nutrient agar containing saccharose, raised transparent mucilaginous colonies which grew freely and covered the surface of the agar. Various trials were then made by cultivating the pure organism at a temperature of 28°C. in sterile grass infusion containing saccharose and in other suitable media. In these the organism grew, producing reducing sugar and a gummy body which was readily precipitated by the addition of alcohol. By this time the organism had been found to be a bacillus, and in order to further study its nature and action on saccharose, as well as to obtain a sufficient quantity of the gum for examination, a culture medium containing the following ingredients was prepared: Saccharose, 100 grms.; potassium chloride, 5 grms.; sodium phosphate, 2 grms.; peptone, 1 grm.; water, 1,000 c.c. Litre portions of this in suitable flasks were sterilised by boiling, plugged as usual with cotton wool, and infected from a pure agar culture of the bacillus. These were incubated at 22°, 28°, and 37° C. respectively. The best growth was at the last temperature. The cultures soon became white and opalescent, like dilute separated milk. A thin film formed on the surface, and when the flasks were allowed to stand without shaking, a layer about a centimetre thick of a mucilaginous substance formed at the bottom of the liquid. When this was disturbed by repeated shaking, it remained suspended in the milky medium. The layer, when undisturbed, disappeared on continued incubation. The culture fluid contained gum, unaltered saccharose, reducing sugar, and a small quantity of acid.

In order to separate the gum and permit of an examination of the sugars, various means were tried, but the most convenient precipitant was found to be alcohol. The presence of the small quantity of acid mentioned above, hinders the precipitation of the gum, but when the solution is rendered faintly alkaline to phenolphthaleïn with sodium hydroxide, precipitation is complete with three or four volumes of strong alcohol. After standing a few hours, the gum is filtered off upon a dry tared filter and

scraped from the beaker, to which it adheres somewhat firmly. If necessary, the adhering particles are treated with a little hot water, precipitated again with alcohol, and added to the other portion. The gum is dried at 100° C., weighed, and the ash determined. On deducting the ash the weight of crude gum is obtained. The alcohol solution is distilled to a small volume and the residual syrup used for determination of the sugars.

The following table shows the progressive formation of gum and reducing sugar in cultures conducted as just described:—

The Fermentation of Saccharose at 37° C. in a Solution containing 100 grms. of Saccharose with Salts, and 1 grm. of Peptone per litre.

Time in Days	0.	2.	3.	4.	5.	7.	12.
Saccharose	100	67	44	31	21	9	6
Reducing Sugars	..	19	36	44	52	60	62
Crude Gum..	..	11	18	23	27	31	31

The reducing sugars are calculated as dextrose. The formation of gum and the inversion of the sugar are seen to go on steadily from the second day, until a balance is practically established between the constituents on the seventh day. The saccharose is not completely inverted, nor is this to be expected.

Marshall Ward and Reynolds Green (Proc. Royal Soc., 65, [414], 79) found a complete inversion of saccharose with their sugar bacteria, but it is just possible that this was brought about by the acidity of the solution (their organism produced in the culture fluid 0·7 per cent. of acetic and 0·057 per cent. of succinic acids) during the chemical manipulation, aud not by the invertase secreted by the organism. In our cultures, the acidity amounted to the equivalent of 0·07 to 0·08 per cent. of lactic acid, and even this small amount produced a notable increase in the invert sugar when not neutralised prior to manipulation. The acids formed by our bacillus had also a distinct solvent action on the gum itself.

The bacillus can grow with marked action upon saccharose in exceedingly poor nutrient solutions. The solutions in which the action has been already shown contained only $\frac{1}{10}$ per cent. of peptone. With smaller amounts the formation of gum is evident from the appearance of the cultures, although the action is naturally not so rapid.

With the object of determining the influence of peptone on the fermentation, cultures containing varying amounts of peptone, but with the other constituents as before, were made and analysed after

five days' incubation. The results, expressed in terms of 100 parts of original saccharose, are given in the following table:—

	Percentage of Peptone in Culture Fluid.				
	None.	0·001.	0·01.	0·1.	1·
Saccharose	99·1*	97·0	71·0	21·0	4·0
Reducing Sugars	0·5	2·0	23·0	52·0	58·0
Crude Gum	0·4	1·0	6·0	27·0	37·0
Acidity as Lactic Acid per 100 c.c.	None.	0·002	0·03	0·08	0·18

It is evident from these results that the fermentative activity is considerably influenced by the presence of peptone. But although an increase of growth was expected from an increase of peptone, the relative formation of gum and mixed reducing sugars could not have been foretold. With increasing amounts of peptone, there is, proportionately, more gum than reducing sugars formed, and there is more saccharose fermented and more acid formed. With no peptone and with 0·001 per cent. of peptone, the changes are too small to enable any deduction to be made. The influence of the peptone on the formation of gum is better seen on comparing the amounts formed in 0·01 per cent. and 1·0 per cent. solutions; in the former, the ratio of gum to reducing sugars is 1 : 3·8, whilst in the latter, it is 1 : 1·6. But since it is probable that the gum is formed from the sugar inverted, we might calculate the ratio between the gum and the sugar wholly inverted, *i.e.*, the saccharose which has disappeared calculated to hexose. With 0·01 per cent. of peptone, this ratio is 1 : 5·1, and with 1·0 per cent., it is 1 : 2·7.

In examining the action of the bacillus upon other sugars, solutions similar to those already employed, but containing other sugars in place of saccharose, were used. Commercial starch glucose was tried first, but although the organism grew well and produced a turbidity and flocculent sediment, there was no disappearance of dextrose and no formation of gum Cultures were also made in solutions containing lactose, levulose, and maltose respectively, but in no case was there any gum formed.

Whether the gum is formed from the sugar by an enzyme extra-cellularly, or is the diffluent sheath or capsule of the organism, it is difficult to prove absolutely. The former view is held by Happ, and also, according to Lehmann and Neumann, by Ritsert, whilst Marshall Ward and Reynolds Green believe that the gum formed by their bacterium was nothing more than the extremely diffluent

* Estimated by difference.

walls of the cell. From our observations, we are of opinion that the latter hypothesis is correct and that the gum is the capsule which has dilated so much that it has ceased to be a capsule, and has become diffused through the culture fluid. The dilatation or swelling is aided by the excreted acid, which thus becomes of assistance to the free movement and growth of the organism by removing what would otherwise be a hindrance. This explains the disappearance of the mucilaginous layer from the bottom of the culture flasks when incubation was prolonged.

Levan was prepared as already described, by growing the bacillus in the sterile saccharine cultural fluid. The fermentation was practically complete in seven days at 37° C., when the culture contained 3·1 per cent. of crude gum (*i.e.*, dried gum, less ash) and 6 per cent. of mixed reducing sugars. On precipitation with alcohol, dissolving in water and reprecipitating several times, a comparatively pure gum was obtained, which was quite free from sugars. After drying at 100° C., the gum purified as above contained 0·125 per cent. of nitrogen, equivalent to 1·0 per cent. of proteids. The ash amounted to 1·4 per cent. Deducting these constituents the preparation contained 97·4 per cent. of pure gum. It is on this figure that the products of hydrolysis, &c. below, are calculated.

(To be continued.)

THE SUGAR INDUSTRY IN FORMOSA.

(Consular Report.)

As in previous years the most important item of exports was sugar, the principal product of South Formosa. Of the total value of exports in 1902, £496,508, the value of the export of sugar alone represented £414,528, or more than 83 per cent., rice to the value of £15,451, hemp £12,965, and salt £12,568, the last a Government monopoly, figuring next in value on the list of exports.

The following table gives the quantity and value of sugar exported from Tainan to Japan and to China and Hong-Kong respectively during 1902:—

Description.	Japan.		China and Hong-Kong.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Cwts.	£	Cwts.	£	Cwts.	£
Brown sugar	673,062	311,403	136,123	60,684	809,185	372,087
White ,, ...	9,271	5,314	54,406	37,127	63,677	42,441
Total	682,333	316,717	190,529	97,811	872,862	414,528

Compared with the export during the year 1901, and also with the average export of the years 1897-1901, the above table shows the following increases and decreases:—

1901.

Description.	Japan.		China and Hong-Kong.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Cwts.	£	Cwts.	£	Cwts.	£
Brown sugar	+ 171,422	+ 85,746	+ 21,866	+ 11,325	+ 193,288	+ 97,071
White "	+ 4,953	+ 1,967	+ 2,980	+ 1,125	+ 7,933	+ 3,092
Total	+ 176,375	+ 87,713	+ 24,846	+ 12,450	+ 201,221	+ 100,163

1897-1901 (Average).

Description.	Japan.		China and Hong-Kong.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Cwts.	£	Cwts.	£	Cwts.	£
Brown sugar	+ 296,948	+ 163,328	— 94,982	— 27,825	+ 201,966	+ 135,503
White "	— 3,437	— 2,525	— 7,864	— 1,189	— 11,301	— 3,714
Total	+ 293,511	+ 160,803	— 102,846	— 29,014	+ 190,665	+ 131,789

From the above figures it will be seen that there was a large increase in the amount of brown sugar exported to Japan as compared with the average amount of previous years, while the trade with China showed a considerable decline. As a matter of fact the tendency of the local Chinese merchants in Tainan is now to ship their sugar as far as possible to Japan and not, as formerly, exclusively to China. Not only are better prices realised in Kobe and Yokohama than in the northern ports of China, but shippers to Japan have less trouble to contend with at the local custom-houses here than those who export to China.

The bulk of the sugar export trade with Japan (Kobe and Yokohama) is at present in the hands of three British firms and five Chinese (Formosa) firms, a small portion being dealt with by a few occasional Japanese and Chinese traders of minor importance.

The British firms in 1902 did about 40 per cent. of the trade, the five Chinese firms about 55 per cent., and the occasional shippers about 5 per cent. No British merchants export sugar to China, the trade being entirely in the hands of Chinese, whose powerful guilds in the north of China keep out any competition by foreigners.

The Formosa crop in 1902 was a good one. Of the total output, 1,066,022 cwts., 907,826 cwts. were exported and 158,196 cwts. were consumed in the island. Of the above total exports, 872,862 cwts. were shipped from the South Formosa port of Tainan (Anping and Takow), while only 34,964 cwts. went from the north of the island.

The market may be said to have opened early in March by the purchase by British merchants of Takow ordinary brown sugar for shipment to Japan at 4 dol. 60 c. per picul (7s. 2½d. per cwt.), against 4 dol. 25 c. (7s. 4d. per cwt.) paid for first sugars in 1901. In consequence, however, of large stocks in Japan, held over from the previous year (one Philippine firm alone held as much as 200,000 piculs (238,095 cwts.) in Yokohama and Kobe), business was most difficult. The Japanese merchants in Yokohama declined to transmit the usual orders for sugar, preferring to let shippers run the risk of the market. The latter, on the other hand, refused to submit to this arrangement, and for several months large shipments went forward to be stored in Yokohama and Kobe. When the Formosa season closed considerable stocks were consequently lying at Yokohama, and little or no business could be profitably transacted. Prices did not improve during the autumn, and it was only in November, when reports of a poor beet crop in Europe caused 100,000 piculs (119,048 cwts.) of Ilo-ilo sugar, stored at Yokohama, to be exported to the United Kingdom and about 40,000 piculs (49,619 cwts.) to North America, that prices recovered and shippers were enabled to dispose of their stocks at a small profit. On the whole the season may be said to have been one of the most unsatisfactory ones on record.

At the close of the year prices in Yokohama *ex* go-down ruled for Tainan and Takow better grade sugars from 5 yen 25 sen to 5 yen 60 sen per picul (9s. 1d. to 9s. 8d. per cwt.) and for Takow ordinary brown, 4 yen 70 sen to 5 yen 10 sen per picul (8s. 1½d. to 8s. 9¾d. per cwt.).

The Osaka Shosen Kwaisha (Osaka Merchant Shipping Company) made a season's contract with the principal exporters to take all their sugar to the Japan ports, the rate being 22 sen a bag of 1 picul (about 4½d. per cwt.) from Takow or Anping to Yokohama, and 20 sen a bag (a little over 4d. per cwt.) to Kobe. Occasional shippers of small lots had to pay 30 sen a bag (6⅙d. per cwt.) to Yokohama.

The financing of the Formosan sugar trade in 1902 was done in about equal proportions by the Japanese banks, Taiwan Ginko (Bank of Formosa) and Sanjushi Ginko (the 34th Bank), and the foreign banks in Hong-Kong and Japan. At times the Formosan rate of exchange did not correspond with the outside market rate and attracted business when in favour of exporters. The bulk of the Chinese business is done by the Japanese banks, owing to the fact that the latter allow overdrafts and accept blank bills (no documents attached). This allows exporters easier financing and at times accommodation bills.

There are two sugar mills with steam power at present at work in this district, one, the Nakagawa Factory in Tainan, a private concern, subsidised by the Government-General, the other, the Formosa Sugar Factory, a registered company largely under Government control. In addition to these two Japanese factories, a native company was

formed in the spring of last year (1902), with a capital of $200,000 (about £15,600), to work another sugar mill in the Tainan district. The mill, which comes from America and cost about £1,300, will have a capacity of five tons of sugar per diem. The factory will be ready for work in the coming season, about November next. No foreign merchants have as yet invested any capital in sugar mills in South Formosa under the regulations promulgated by the Government-General on June 14th, 1902, for the encouragement of the sugar industry, a translation of which was given in the report (supplementary) of the trade of this district for the year 1901.

As the Government-General, however, is strongly urging and encouraging the introduction of foreign cane-crushing machinery, it is most probable that many small mills will be erected by native sugar manufacturers in the near future. The mills most likely to be required will be those with a capacity of turning out from three to five tons of sugar per diem (12 hours).

The Formosa Sugar Factory, which commenced work at the end of 1901, was estimated to be able to turn out about 30 tons of sugar a day, or about 4,500 tons during a season of 150 working days, but up to the present, owing to various causes, such as lack of experience in working the machinery, and consequent frequent stoppages, as well as to difficulty in getting a sufficient quantity of cane, this estimate has not been realised. The output during last year (1902) was less than 20,000 piculs (1,190 tons).

The capital of the company is 1,000,000 yen (about £100,000) in 50 yen shares. The receipts and expenditure for the year 1902 were as follows:—

Receipts.	Amount. Yen.
Subsidy	55,780
Proceeds of sale of sugar, &c.	136,696
Miscellaneous	10,878
Total	203,354
Expenditure.	
Material	104,082
Taxes	24,491
Salaries and wages	12,065
Travelling expenses	3,355
Miscellaneous	9,728
Balance	49,633
Total	203,354

Out of the balance of 49,633 yen (about £5,105) a dividend of 1,683 yen per share was paid, absorbing 33,660 yen (£3,462).

It is satisfactory to note that the three crushing mills in use at the factory as well as two out of the three engines are of British manufacture, and, I am informed, give every satisfaction. They were purchased for the company in Glasgow by the London agency of the Japanese firm of Mitsui Brothers.

Java.

The weather during the past season was generally much more favourable for sugar planting purposes and for the growth of the cane than in either of the two preceding years. On some estates in the eastern districts of the island, where, owing to the nature of the ground, the water was unable to penetrate, the rains which fell during the planting season in 1901 had an unfavourable influence on the production, as planting had to be done on ground which had not been sufficiently exposed; while the dry monsoon in 1902 commenced so exceptionally early that on many estates, where the ground held insufficient moisture, the cane quickly dried up, to the detriment of the percentage of sugar. The area planted was slightly larger than in 1901, and the production on the whole may be taken as favourable. The total crop amounted to the record one of 848,263 tons, as compared with the previous highest of 766,238 tons in 1901.

As already stated, prices receded gradually to the lowest level ever known—4½ guilders per picul, equal to 6s. 2d. per cwt.—and many mills worked at a loss.

With reference to cane diseases, Mr. Vice-Consul McLean reports as follows :—

"There was less injury experienced from root disease, owing to heavier manuring with sulphate of ammonia, and the discovery of new varieties of cane which are proof against this sickness.

"The growing of cane from seed and from crossing has considerably increased, as the varieties produced, besides combining a large cane production with a high sugar percentage, appear to better withstand the cane diseases.

"The 'sereh' has thus met with a check, but without special measures in the cultivation of the plant, this disease will continue to show its prejudicial effects."

Few cases of sickness occurred among the cattle, but in view of the deterioration of these animals in Java, and the gradual increase in the area planted, the transport of cane by rail is becoming year by year more extended,

Owing to the exceptionally long dry monsoon and the irregularity of the rains which have so far fallen, prospects for a large crop in 1903 are not very favourable, but much depends on the weather during the early months of the year. As regards prices, the outlook is far more encouraging than was the case last year.

The following figures show the production during the past five years :—

Year.	Quantity. Tons.
1898	683,032
1899	730,842
1900	710,150
1901	766,238
1902	848,263

Austria-Hungary.

Trieste.—In 1902, 2,489 metric tons of sugar were shipped from Trieste to the United Kingdom as compared with 497 tons in the previous year. To British India the amounts were 47,200 and 59,600 tons respectively. The decrease in the last case was caused by the levying of increased countervailing duties in India.

Italy.

The value of the sugar imported into Italy during 1902 amounted to £213,392, a decrease of £177,316 as compared with the previous year.

Netherlands.

In 1902 the amount of beet and cane sugar imported into Holland reached 171,588 tons, of which 1,867 tons came from the United Kingdom. Germany sent the larger amount. In 1901 the amount was 111,220 tons.

The exports were (beet and cane):—

1901.		1902.	
Total. Tons.	To United Kingdom. Tons.	Total. Tons.	To United Kingdom. Tons.
62,568	52,402	103,633	71,421

Norway.

Imports of sugar into Norway during 1902 and 1901:—

1902.		1901.	
Quantity. Tons.	Value. £	Quantity. Tons.	Value. £
37,039	486,844	36,433	456,569

Turkey.

Baghdad.—Loaf sugar was largely imported, principally from Marseilles, but its carriage from Basrah to Baghdad by native sailing craft ceased during the year owing to underwriters declining to insure on account of the heavy claims made against them. Hamadan and its district, which was previously supplied exclusively from Baghdad, is now receiving large quantities from Russia, probably three-fourths of the loaf sugar now imported into Hamadan being Russian. The extra cost of transport to Kermanshah prevents Russian trade at present from penetrating there to any great extent.

The value of the sugar imported from Europe, in 1902, was £143,710; that from India, £21,960. The figures for 1901 were £6,925 and £1,600, respectively.

China.

Kiungchow.—The exports of brown sugar increased from 192,752 cwts., valued at £76,836, to 294,803 cwts., valued at £101,246. White sugar showed a marked decline from 37,281 cwts., valued at £24,087, to 27,254 cwts., valued at £13,472.

Ningpo.—Sugar, one of the most important imports into Ningpo, is the only item in the import returns which shows any considerable increase, 233,381 cwts. of brown and 251,303 cwts. of refined sugars having been imported in 1902, against 143,505 and 187,908 cwts. respectively in 1901. White sugar has declined slightly, and there has been a considerable falling-off in the import of native brown sugar.

Swatow.—The exports of sugar during 1901 and 1902 were as follows:—

	1901.		1902.	
	Cwts.	£	Cwts.	£
Brown	969,526	413,901	762,219	288,330
White	681,188	445,541	534,536	307,217

Wuchow.—Sugar, formerly one of the biggest items on the export list, has dwindled from 3,300 tons in 1898 to 68 tons in 1902, chiefly owing to the flooding of the cane fields last year, and in a lesser degree to the diversion of the export to Pakhoi.

Japan.

Till the month of June the sugar market was very dull, from July to September it was rather better, some trade being done in Kobe in Osaka refined at a gradually advancing price. The presence, however, of heavy supplies of German beet had a depressing effect on the market, which closed at the end of the year rather dull. A Bill was passed in the United States House of Representatives at the close of 1902, reducing the import duty on Philippine sugar from 75 to 25 per cent. It is expected that this may have some effect on the market here, as the amount of sugar brought from the islands will probably decrease when the Bill becomes law. One of the Tokio papers is also responsible for a statement made quite recently to the effect that a sugar refinery is to be established in Formosa, with a capital of 1,000,000 yen. A subsidy will probably be granted to it. A British firm in Yokohama is said to be interested.

The following table shows the value of the sugar imported during the year 1902 from Japan's principal suppliers:—

Country.	Value. £
Germany	332,782
Dutch India	273,719
Hong-Kong	237,379
Austria-Hungary	117,321
Philippine Islands	104,864
China	85,894
Belgium	12,491

In 1901 the value of the sugar imported from Germany was £899,529; from Hong-Kong, £1,109,615; and from Austria-Hungary, £414,668. These figures are much in favour of that year therefore, but it should be remembered that the desire to escape the new sugar duty levied in October 1901, was mainly responsible for the high value during that year of this particular import.

Kobe and Osaka.—Imports of raw and refined sugar:—

	1900.		1901.		1902.	
Raw:—	Tons.	£	Tons.	£	Tons.	£
Kobe	18,195	163,257	20,624	212,164	12,520	96,728
Osaka	26,332	294,193	24,842	277,775	35,818	334,824
Refined:—						
Kobe	40,731	541,031	50,821	697,690	12,169	127,079
Osaka	..	..	453	6,119	7,256	77,256
Sundry:—						
Kobe	..	3,733	..	1,591	..	1,813
	..	1,002,214	..	1,195,339	..	637,700

The raw sugar came chiefly from Java and the Philippines to the refineries at Osaka.

Hong Kong, which in 1900 sent over £1,000,000 of refined to all Japan, exported barely £150,000 in 1902. The imports of beet sugar from Germany and Austria-Hungary have also fallen off largely. The importation in 1901 was considerably in excess of the demand, but was caused by a desire to get sugar in before the imposition of the Consumption Tax, and consequently large stocks were carried over.

The duty on sugar of Dutch Standard No. 14 and lower grades is 20·4 sen (5d.) per 133 lbs., and Hong Kong refined sugars suffer, not only from the excise alluded to in last year's report, but also from the rebate of this duty allowed by the Japanese law brought into operation on October 1st, 1902, and to remain in force till March 31st, 1907, which lays down that "any person who imports sugar of Dutch standard No. 14 or lower grades, and declares the same as material for refined sugar may, when so manufactured, claim a refund of import duty paid, the claim to be made within one year from date of importation under a certificate from the customs."

The year 1902 opened with heavy accumulated stocks of refined sugars, chiefly German beets, imported in the previous year in order to escape the heavy Consumption or Excise Tax, which came into operation on October 1st, 1901, and it was not until towards the latter end of the year that these were worked off, the market in the meantime being characterised by general dulness, attended by a low range of prices. There was some little recovery towards the close of the year, but the year taken as a whole was a very bad one both for foreign imported and native refined sugars. The production of the latter is,

however, gradually increasing, and the Japanese refineries are now taking a prominent part in supplying the needs of the country.

The import of both white refined and brown sugars was much restricted as compared with 1901, although figures of browns were to some extent maintained by importations for the native refineries.

Egypt.

Port Said and Suez.—The exportation of sugar has steadily increased for the last five years. The quantity exported last year was 7,876 tons, as against 7,400 tons exported in 1901; of the above quantity 4,274 tons were sent to India and other British possessions in the Far East, Turkish Arabia taking 3,063 tons. It is presumed that the demand for Egyptian native sugar will increase next year, principally for Karachi, Bombay, and Calcutta.

Zanzibar.

Pemba.—Sugar to the value of £3,206 was imported into Pemba, chiefly from India and Mauritius.

Philippine Islands.

The sugar industry has, more than any other, suffered by reason of the lack of capital and labour and the prevalence of rinderpest, the water buffalo being indispensable for cultivation and transport purposes. During the five years, 1894-98, on an average upwards of 3,200,000 piculs (200,000 tons) were annually exported, but in 1902, although a considerable improvement on the previous year, the total only reached 1,470,000 piculs (91,870 tons).

The exports of raw sugar during 1901 and 1902 were as follows:—

Country.	Value. 1901. £	Value. 1902. £
Hong-Kong	196,327	283,512
Japan	223,252	148,279
China	—	65,046
United States	19,473	61,115
United Kingdom	38,665	—
Other countries	3	17,345
Total	477,720	575,297

Porto Rico.

Of the 2,347,520 acres which the island contains, 61,556 acres are in cane. The opportunities for increasing the sugar cultivation are many, amongst which are: the re-cropping of former sugar lands long lain fallow and returned to pasture, the breaking-up of tracts hitherto untouched, and bringing into cultivation, through the modern methods of irrigation, of blocks of land upon which hitherto crops could not be risked through uncertainty of water supply.

During the year the large central sugar factory at Guanica, mentioned in last report, came into work on the crop of 1902-3, the results of which will, no doubt, largely influence the installation of similar factories in other parts of the island. In other directions many improvements in methods and machinery are reported, which must necessarily increase the output, which is estimated to reach 105,000 tons.

Rumours are continually cropping up of new sugar ventures, and much negotiation has actually reached documentary form, only to linger in that state without development, as capital still appears shy for reasons difficult for outsiders to understand.

In spite of everything favourable to the ordinarily careful speculator, such as suitable lands, cheaper labour than usual, in addition to a privileged market, enterprise in sugar is very backward.

The conditions for profitable sugar growing are somewhat different from what they were even a short time ago.

It is now considered that a central factory would not pay with less than an annual output of 5,000 tons, to produce which the control of 1,000 acres of cane must be secured. The instalment of a factory of the foregoing capacity is estimated to cost £100,000, a sufficiently important sum to instil caution into would-be speculators, although the very advantageous position of Porto Rico over its sugar growing rivals outside the United States must appear attractive and cannot be controverted.

Arroya de Guayama.—Mr. Vice-Consul McCormick reports as follows:—

Owing to free trade with the United States of America and the enforcement of the United States tariff on all imports from foreign countries, there are practically no direct imports in this district from the United Kingdom, and very few from her colonies.

Some trifling pieces of machinery are brought from Glasgow (Scotland) for repairs to sugar plantation machinery, but of so small a value that it is practically not worth taking into consideration as a trade factor.

The exports during 1902 were as follows:—

			Dol.	c.	£
Sugar.. ..	Lbs. ..	9,517,176 ..	290,911	70 ..	58,182
Molasses ..	Gallons..	421,945 ..	68,570	47 ..	13,714

As all these were free of duties in the United States of America, the difference in price is so enormous that they cannot be exported to other countries, except in the case of molasses, which, in spite of entering free of duty into the United States, nearly all that is made in this district is exported to the Dominion of Canada, 395,645 gallons, of the value of $64,064 23c. (£12,812), being sent to that country during the past year, thus giving employment to a certain number of British vessels.

Ponce.—The British Consul states: In spite of the low price of sugar during the year, plantations are improving, owing to free trade with the United States, the import duties thus avoided being equal to a bonus of 1dol. 68c. per 100lbs. of 96° crystals. This advantage enables planters to work with profit, which could be easily increased if up-to-date machinery and appliances were used in the manufacture of sugar, and lands were properly manured. There are in this district no less than 16 plantations, some of them large ones, which yet make only muscovado sugar, thus the large export of molasses, which amounted this year to £69,995.

Two large central sugar factories have been put up, Aguirre in Port Jobos of 15,000 tons capacity, and Guanica Centrale in Port Guanica of 20,000 tons capacity, both with headquarters in Ponce, but distant, the first about 30 miles to the east, the other 25 miles to the west. Both are too far away from local plantations, besides their capacity is fully taken up with adjacent lands. Aguirre has been at work on two crops, but no official statement that I know of has been published, and private reports differ. Guanica will make the first crop in 1903, or next year. I gave a full description of this factory in my last year's report. If the result is a favourable one, other central factories will soon spring up, and if so, about 60,000 tons of sugar could be made in this district, including Central Aguirre, which takes in part of Guayama district.

Some 36,000 metric tons of sugar, to the value of £241,000, were exported during the year, and for local and island consumption about 6,000 tons were used.

Mayaguez.—No new central sugar factories have been established in this district during the past year, notwithstanding the fact that there are large tracts of uncultivated cane lands very suitable for such improved sugar making, in which British capital might be employed to advantage.

PUBLICATIONS RECEIVED.

THE OPTICAL ROTATING POWER OF ORGANIC SUBSTANCES AND ITS PRACTICAL APPLICATIONS. By Dr. H. Landolt. Translated by Dr. J. H. Long. The Chemical Publishing Co., Easton, Pa. $7·50.

Since the publication of the English edition of Dr. Landolt's "Handbook of the Polariscope" in 1882 so much progress has been made in the domain of physical chemistry that another edition was greatly needed. This the author has supplied by the above work, which is entirely re-written. It will be welcomed by all chemists interested in this branch of science, whether they have the time or not to follow the rapidly extending literature on the subject. The book embraces the whole field of optical activity and extends to 728 pages of text, with author's and translator's preface, a table of

contents and a good general index, and index of active substances. It is divided into six parts. Part I. treats of "The General Conditions of Optical Activity"; Part II., "Physical Laws of Circular Polarisation"; Part III., "Numerical Values for the Rotating Power. Specific Rotation"; Part IV., "Apparatus and Methods for the Determination of the Specific Rotation"; Part V., "Practical Application of Optical Rotation"; and Part VI., "Constants of Rotation of Active Bodies."

The remarkable developments in the field of optical activity brought about by the hypothesis of van't Hoff and Lebel on the relation between the rotating power and the atomic structure of carbon compounds, has aroused the greatest interest amongst chemists. "Since 1879, when this doctrine was still in its infancy, numerous investigations suggested by it have been carried out, the results of which have abundantly confirmed the theoretical requirements in all cases, so that to-day the theory may be presented in complete and fully developed form." In the same time, we are told, the number of optically active substances has increased from 300 to over 700, and additions have been made by the translator which brings the subject-matter of the work down to 1902. It is largely with regard to these and other developments in specific rotation, a knowledge of which is essential to the scientific chemist, that the book has to deal.

But it has also a practical side, and to those interested in the application of the specific rotation of sugars to the sugar producing and refining industries, the chapter on multirotation and the discussion of the theoretical considerations on which the construction of polarimeters and saccharimeters depend, will be of great value. Special attention may be directed to the full description of Lippich's work on the polarisation of light and the principles on which double, triple, and quadruple "fields" are obtained by means of his prisms. The construction of half shadow instruments is now so perfect that nothing seems left to be desired. We are told on page 388 that "the mean error of an adjustment for a saccharimeter with double field is about $\pm$ 0·06°VV, and for the saccharimeters with triple field about 0·03°V"—that is per degree of the sugar scale. Much valuable information is also given on the illumination of the instrument and the different sources of light.

Landolt's handbook has always been a standard work on the subject of which it treats, and the present volume will command equal respect in laboratories of organic research and those of the sugar industry. The work of the translator appears to have been done with great care. The book is well printed, with few errors, and reflects great credit on the publishers.

T. L. P.

The new German tariff fixes the duty on saccharine at 80 marks per kilo.

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. Thompson, C.E., F.C.S., M.I.M.E., Chartered Patent Agent, 6, Lord Street, Liverpool ; and 322, High Holborn, London.

ENGLISH.—APPLICATION.

16750. G. Harrison, London. (Communicated by the Firm of F. Hlavati & Co., Italy.) *An improved manufacture of sugar.* 30th July, 1903.

ABRIDGMENTS.

17035. F. Scheibler, Aix-la-Chapelle, Prussia. *Improvements in and relating to double cutting machines for cutting sugar and packing the cubes ranged.* 1st August, 1902. This invention consists of a double-action machine for dividing sugar slabs or plates into cubical lumps of desired size and shape and forming a ranged layer, characterised by the feature that for the purpose of avoiding waste, two pairs of cutters are arranged at a right angle to, and operate independently of, each other, so that the feed of the sugar can be adjusted in both directions and thereby each pair of cutters is caused to make cuts of desired distances apart.

20851. Dr. Hermann Schrader, Honningen-on-the-Rhine, Germany. *Improved process for obtaining and utilising the organic acids contained in the residuary liquors of molasses.* 24th September, 1902. This invention refers to a process for the extraction of organic acids from the lyes of molasses (vinasse) which consists in first concentrating the lyes of molasses freed from sugar, then mixing the same in a warm state with such a quantity of sulphuric acid as is necessary for the neutralization of the alkali, allowing the liquor to cool, then separating therefrom the eliminated potassium sulphate, then separating from such separated liquor the still dissolved potassium sulphate, treating the resultant liquor with water or steam, precipitating the remaining sulphuric acid, separating the liquor from the precipitate obtained, and treating said separated liquor in a hot state with decolorising agents.

21102. H. Winter, Charlottenburg, Germany. *Improvements in stirring devices, more especially for mixers for sugar masse-cuite.* 27th September, 1902. This invention relates to improvements in stirring devices for masse-cuite cooling apparatus and the like, and has for its object to effect a mixing of the mass from the centre to the periphery, and *vice versa*; that is, a thorough mixing of the warmest and coolest layers in the mixer. This device has drums of stirring blades rotating round a secondary shaft revolved round the main shaft, the blades being curved, or provided with ribs or pivoted, and supported in one position by pointed or other stops.

21146 J. Wetter, London. (Communicated by M. Weinrich, Yonkers, United States of America.) *Improvements in the purification and preservation of raw sugar.* 29th September, 1902. This invention, which relates to the treatment of raw sugar before it undergoes the ordinary refining process, consists in mixing with the raw sugar a small percentage of finely pulverised lime to form a sucrate of lime with the sugar of the molasses covering the sugar crystals, and to decompose organic impurities contained in said molasses, and then heating and airing the mixture; then, by washing, separating the impurities from the sugar crystals and the sucrate of lime, and finally removing the added lime from the dissolved sugar crystals and sucrate of lime and from the wash syrup.

GERMAN.—Abridgments.

142126. Kemper & Lonsberg, of Nuenkirchen-Rietberg (District of Minden, Westphalia). *Centrifugal.* 13th February, 1901. The fly wheel of the centrifugal is carried along with the spur wheel of the gearing by means of a spring key, and during the working of the machine travels on two ball bearings, whilst, when the driving wheel is stationary, it travels on only one ball bearing and on the hub of the driving cog wheel, with the object of obtaining a rapid brake action by the broad hub bearing.

142003. Wilhelm Köllmann, of Barmen. *Shredding machine.* 22nd February, 1902. This shredding machine has a knife drum revoluble on a horizontal axis, on the outer periphery of which drum the knives are mounted. The roots to be shredded are fed to the knives through a horn shaped tapering feed chute lying at the front of the periphery of the knife drum in the direction of rotation.

Copies of all published specifications with their drawings in these lists can be obtained from W. P. Thompson & Co., 6, Lord Street, Liverpool, at One Shilling a copy for English or American Patents, and Two Shillings for German. In ordering please give number and date.

Patentees of Inventions connected with the production, manufacture, and refining of sugar will find *The International Sugar Journal* the best medium for their advertisements.

The International Sugar Journal has a wide circulation among planters and manufacturers in all sugar-producing countries, as well as among refiners, merchants, commission agents, and brokers, interested in the trade, at home and abroad.

The 1902-03 Cuban sugar crop may possibly attain to 1,000,000 tons.

Dr. Hager's retirement from the post of Editor of the *Deutsche Zuckerindustrie* has taken effect sooner than was first announced, as he has already left that journal.

IMPORTS AND EXPORTS OF SUGAR (UNITED KINGDOM,)

To end of July, 1902 and 1903.

IMPORTS.

Raw Sugars.	Quantities.		Values.	
	1902.	1903.	1902.	1903.
	Cwts.	Cwts.	£	£
Germany	3,942,188	2,206,302	1,374,089	894,928
Holland	219,837	138,078	70,777	51,708
Belgium	375,813	608,416	137,163	253,689
France	1,478,791	459,506	579,363	202,303
Austria-Hungary	52,515	1,411,283	18,036	594,545
Java	....	....	....	....
Philippine Islands	....	70,646	....	25,285
Peru	80,312	196,111	27,121	76,771
Brazil	495,726	65,720	162,432	25,696
Argentine Republic	522,432	178,283	193,261	80,432
Mauritius	263,976	222,170	92,566	78,546
British East Indies	99,962	136,169	38,373	48,842
Br. W. Indies, Gúiana, &c.	1,128,139	486,138	662,165	303,442
Other Countries	108,181	715,739	42,289	327,798
Total Raw Sugars	8,767,872	6,894,561	3,397,635	2,963,985
Refined Sugars.				
Germany	8,669,123	8,449,783	4,567,926	4,389,327
Holland	1,443,234	1,267,844	836,099	730,632
Belgium	106,854	82,901	62,567	48,258
France	1,941,525	511,046	1,006,438	293,085
Other Countries	11,030	684,946	5,374	337,107
Total Refined Sugars	12,171,766	10,996,520	6,478,404	5,798,409
Molasses	743,845	876,297	144,962	164,968
Total Imports	21,683,483	18,767,378	10,021,001	8,927,362

EXPORTS.

British Refined Sugars.	Cwts.	Cwts.	£	£
Sweden and Norway	24,699	13,365	13,875	6,968
Denmark	81,195	58,144	41,788	31,907
Holland	39,124	36,284	20,430	19,675
Belgium	5,542	4,708	2,882	2,356
Portugal, Azores, &c.	6,021	4,201	3,056	2,263
Italy	13,874	5,672	6,526	2,582
Other Countries	189,704	346,944	117,191	210,863
	360,159	469,318	205,748	276,614
Foreign & Colonial Sugars.				
Refined and Candy	32,525	24,841	19,938	15,204
Unrefined	47,614	35,966	24,728	18,706
Molasses	1,195	1,220	427	639
Total Exports	441,493	531,345	250,841	311,163

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1903. Tons.		1902. Tons.
Total Receipts, 1st Jan. to August 13th.	1,125,103	..	1,018,506
Receipts of Refined ,, ,, ,, ..	1,149	..	12,826
Deliveries ,, ,, ,, ..	1,055,930	..	1,021,595
Consumption (4 Ports, Exports deducted) since 1st January	995,286	..	997,061
Importers' Stocks (4 Ports) August 12th.	73,558	..	22,222
Total Stocks, August 19th	278,000	..	137,515
Stocks in Cuba ,, ...	232,000	..	245,377
	1902.		1901.
Total Consumption for twelve months ..	2,566,108	..	2,372,316

CUBA.

STATEMENT OF EXPORTS AND STOCKS OF SUGAR, 1902 AND 1903.

(Tons of 2,240lbs.)	1902. Tons.		1903. Tons.
Exports	442,442	..	661,540
Stocks	361,863	..	293,027
	804,305	..	954,567
Local Consumption (seven months)	22,341	..	23,145
	826,646		977,712
Stock on 1st January (old crop)	19,873	..	42,530
Receipts at Ports up to 31st July	806,773	..	935,182

J. GUMA.—F. MEJER.

Havana, 31st July, 1903.

UNITED KINGDOM.

STATEMENT OF SEVEN MONTHS' IMPORTS, EXPORTS, AND CONSUMPTION IN UNITED KINGDOM.

	1903. Tons.		1902. Tons.		1901. Tons.
Stock	119,605	..	114,894	..	65,549
Imports, Raw Sugar, Jan. 1st. to July 31st	344,728	..	438,393	..	429,278
,, Refined, Jan. 1st to July 31st ..	549,826	..	608,588	..	631,865
,, Molasses, Jan. 1st to July 31st ..	43,815	..	37,192	..	51,898
	1,057,974		1,199,067		1,178,590
Stock, in 4 chief Ports	112,478	..	187,386	..	159,569
	945,496		1,011,681		1,019,021
Exports (Foreign and British Refined) ..	26,067	..	98,148	..	147,660
Apparent Consumption for Seven Months..	919,429		913,533		871,361

Stocks of Sugar in Europe at uneven dates, August 1st to 20th, compared with previous Years.

In thousands of tons, to the nearest thousand.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	Total 1903.
117	712	579	142	137	1689

	1902.	1901.	1900.	1899.
Totals	1721 ..	854 ..	697 ..	876

Twelve Months' Consumption of Sugar in Europe for Three Years, ending July 31st, in thousands of tons.

(From Licht's Monthly Circular.)

Great Britain.	Germany	France.	Austria.	Holland, Belgium, &c.	Total 1902-03.	Total 1901-02.	Total. 1900-01.
1625	803	565	412	504	3966	4181	4132

Estimated Crop of Beetroot Sugar on the Continent of Europe for the current Campaign, compared with the actual crop of the three previous Campaigns.

(From Licht's Monthly Circular.)

	1902-1903. Tons.	1901-1902. Tons.	1900-1901. Tons.	1899-1900. Tons.
Germany	1,750,000 ..	2,304,924 ..	1,984,186 ..	1,798,631
Austria	1,070,000 ..	1,302,038 ..	1,094,043 ..	1,108,007
France	890,000 ..	1,183,420 ..	1,170,332 ..	977,850
Russia	1,215,000 ..	1,098,983 ..	918,838 ..	905,737
Belgium	230,000 ..	334,960 ..	393,119 ..	302,865
Holland	105,000 ..	203,172 ..	178,081 ..	171,029
Other Countries.	345,000 ..	393,236 ..	367,919 ..	253,929
	5,605,000	6,820,733	6,046,518	5,518,048

GEORGE MARTINEAU, C.B.

THE

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☞ The Editor is not responsible for statements or opinions contained in articles which are signed, or the source of which is named.

GEORGE MARTINEAU, C.B.

Amongst those individuals whose life has been intimately bound up in the cause of the sugar industry, particularly as regards the burning question of bounties, none have been more assiduous in their exertions, more tireless in their endeavours for the common weal, and yet withal less prominent in their work than Mr. George Martineau, C.B. To quote his own words, he has "had no career apart from sugar;" nevertheless as his direct connection with the refining industry practically terminated at a comparatively early period of his life, it may be taken for granted that his strenuous endeavours to bring about fair and natural conditions in the world's sugar industry by the abolition of the Continental bounty system and its accompanying evils, have been more disinterested in their character than would have been the case had he continued an active member of a declining trade. Under the circumstances he would have been justified in working in a prominent and public groove; but as a matter of fact he appears to have done his best work with his pen, and behind the scenes; the public platform seldom knew him. Now at length he has gained the consummation of his labours in the abolition of bounties, cartels, and all those artificial stimulants of the beet sugar industry. But only those of us who have been most intimately connected with his work know what we owe to him for these results.

We are therefore justified in supposing that some particulars of Mr. Martineau's career will now seem appropriate, and we have

pleasure in accompanying them with an excellent likeness of him prepared from a recent photograph.

The subject of our sketch was born in 1835 and educated privately and at University College, London. In 1856 he became a sugar refiner and 1861 saw his marriage to a daughter of the late Major Roderick MacKenzie of Kincraig, a Highland Laird in Rosshire. The study of sugar refining in all its branches was his absorbing interest until the question of the sugar duties became a burning one in 1863-4. Certain faddists, who posed as authorities in fiscal matters with which they had no practical acquaintance, hit upon the bright idea that it would be so much more simple (and scientific?) to have only one duty on sugar instead of a cumbersome scale. This created a great storm in the fiscal teacup. In those days (1864) he co operated with, amongst others, the late Alfred Fryer, founder of the *Sugar Cane*, a man of infinite wit, who was a tower of strength in this little battle. On the other side, among others, was T. B. Potter, M.P., who fancied—erroneously as many men have done since then—that the mantle of the immortal Cobden had fallen on him. The amount of absolute nonsense that was talked about this craze was a fairly good foretaste of what was afterwards experienced in the bounty question. But they had no difficulty in showing up the fallacy to Mr. Gladstone, who gave it its quietus in his budget speech of 1864, by simply pointing out that if sugar containing 50 per cent. of extractible sugar were charged the same duty as sugar containing a hundred per cent., it would pay exactly double the duty charged on the other, and that therefore the scheme amounted to a prohibition to the importation of all raw sugar, the shutting out of our own colonial sugars, and the destruction of sugar refining in this country. So much for the political economists of 1864.

A few years later when beetroot sugar began to appear upon the market and a study of the *Journal des Fabricants de Sucre* revealed many new ideas with regard to the chemistry of sugar, Mr. Martineau was led to devote six months in the laboratory of his old college to investigations in this new subject, and he subsequently constructed and conducted with his own hands a laboratory in his Mincing Lane office. He was thus enabled, long before his brother sugar refiners had turned their serious attention to the matter, to analyse all samples of sugar which came under his notice, and thus complete his knowledge of their relative values. The information thus obtained came in very useful when some years later he had to act as Expert Adviser to the British Delegates at the Conferences of 1875-6-7, where "saccharimetry" became a great bone of contention.

The constant observation of the progress of the beetroot industry and of the many scientific questions connected with it was naturally of great interest to Mr. Martineau, and he kept himself well posted

up in all that was going on. In 1871, accompanied by two engineers, a sugar planter, and a chemist, he made a long tour through France, Belgium, Germany, and Austria, where, in every great centre of the industry, they received the most cordial and friendly treatment, and had the opportunity of seeing and studying the various kinds of sugar factories and refineries, and all the greatest sugar machinery engineering works in Europe.

Soon afterwards he made attempts to interest British farmers in this new industry. A distinguished agricultural authority, secretary to the Central Chamber of Agriculture and writer on farming questions in the *Times*, took it up warmly, and he was given much assistance by Mr. Martineau in carrying out experiments on his farm. The results appeared in the Journal of the Chamber of Agriculture of 1871. Mr. Martineau tried to arouse the interest of farmers all over the country, though a profit of £3 per acre did not seem to tempt them in those days. But as, unknown to them, the bounties were close upon them, it was doubtless fortunate that nothing came of it.

In 1872 came the great meeting of all the sugar refiners of the United Kingdom. They—or some of them—saw that bounties on a large scale were looming in the future, and had already struck the loaf sugar industry (with which Mr. Martineau was associated), and that the time had come to stop the progress of this form of ruin. They little thought that it would take exactly 30 years to induce the Government and Parliament to take effectual action for the maintenance of free trade in sugar.

The refiners appointed a committee, for which Mr. Martineau acted as secretary, and it became his duty to write the various communications with the Government, which went on as the matter became more complicated, constantly increasing in quantity, quality, and intricacy. The French raw sugar manufacturers were strongly on their side at first, because they received no bounty themselves and they saw that the big bounty obtained by the Paris refiners deprived the raw sugar producers of their export market and made them dependent on the Paris monopoly. The British Committee therefore worked in combination with them, and had the satisfaction in 1873 of getting the National Assembly to vote for Refining in Bond and the consequent abolition of the Paris bounties.

The British Government, worried by the importunity of Mr. Martineau's Committee, carried on much correspondence with the French Government, which resulted in a series of abortive International conferences. The British delegates did not understand the subject, consequently in 1873 the refiners were obliged to point out to Mr. Gladstone that the Convention he was about to ratify would not hold water. He agreed, and refused to ratify it. This was the origin of Mr. Martineau's connection with the Foreign Office.

The idea of forming a Beetroot Sugar Association originated with Mr. Martineau. The object he had in view was to institute some method of getting rid of the constant disputes about weight and analysis of beetroot sugar delivered to refiners in this country. This association has since proved an indispensable adjunct to the harmonious working of this trade.

He was also one of the founders of the Railway and Canal Traders' Association, in conjunction with Mr. James Duncan and Mr. J. I. Rogers, of Messrs. Joseph Travers and Sons. The London Coal Dues was another matter which he took up, and they at last succeeded in getting them abolished. It was a tax on the manufacturing industry alone, and therefore most unjust in its incidence. It provided funds for great London improvements, to which the merchant princes contributed nothing, except on the coals they burned in their office fireplaces.

To go back to his connection with the bounty question, there were two occasions when the sugar duties in the United States were altered, when the American Government (unwittingly probably) gave for a time a very serious bounty on the export of refined sugar owing to the drawback being excessive. On both occasions Mr. Martineau promptly detected the injustice involved and was able to explain the exact amount of the bounty and how it ought to be abolished. The first time he worked the matter alone, in conjunction with a Canadian friend. He wrote articles for the American papers and succeeded in exposing the abuse and getting it abolished.

On the second occasion (1885) the Sugar Refiners' Committee addressed our Government with regard to it, but the British Embassy at Washington turned out to be quite unfit to cope with the matter. Mr. Martineau made out a statement of our case, and a deputation from his committee went over to America and got the thing put to rights. It seems unfortunate that Mr. Martineau was not included in this deputation, all the more as the latter made full use of his arguments and figures, and he certainly should have had the credit for the successful results which the deputation achieved.

By the way, it may be noted here that on that occasion about 100,000 tons of American refined sugar came over. When the bounty was abolished, the export ceased. But the British consumer did not discover any difference in the price of sugar when that happened.

In April, 1879, there was an important deputation from the sugar refiners to Lord Salisbury, at which Mr. Martineau put the case for them. On the following day the West India Committee had a deputation to Sir Michael Hicks-Beach, who was then Colonial Secretary, and it is interesting to read his reply to what was put before him by Mr. Nevile Lubbock and others (Sir Nevile Lubbock was then Vice-Chairman of the Committee). The Right Honourable gentleman said, "I must say you have a substantial grievance—a

grievance which ought, not merely in the interests of the West Indian Colonies, or of the sugar industry in this country, but in the interests of the country at large, to be met in some way or other. It does not seem to me under present circumstances that you have that fair play which ought to accompany free trade, though whether the remedy you suggest is the right one is a matter I should not wish to discuss now."

In October, 1880, the National Anti-Bounty League was formed, of which Mr. Nevile Lubbock was a member of the Executive Council. During the discussion of Baron de Wones' Conference in 1888, Mr. Martineau's letters to the press were constant, and, as has always been the case, most lucidly explained the situation, the point being then urged by him that the abolition of bounties would not have the effect of increasing the average price of sugar to the consumer, but that by the destruction of the artificial stimulus the average price, governed by the laws of supply and demand, would be, on the whole, lower. His long correspondence with Sir Thomas Farrar took place in the autumn of that year.

He was fortunate in having a first rate British delegate at the conferences of 1875-6-7, where he acted as Expert Adviser; and if the Government had had the common sense to agree to a penal clause the matter would have been settled. France pointed out, most reasonably, that it was impossible for them to agree to abolish their bounty unless they had some security that they would not be shot at by bounties from other countries. Our Government refused to see the point, and the Convention of 1877, a most excellent one, fell through. But we had enlightened the French Government so thoroughly that they very soon put their house in order and the great Paris refiners' bounty ceased to a great extent.

But, as Mr. Martineau had foretold, the new competition of German and Austrian refined granulated sugar as well as loaf very soon sprang up and became a much more serious thing to the British refiners in general than the previous French bounty, which was only on loaf sugar.

Then came the Select Committee of the House of Commons in 1878 and 1879, which was brought about by Mr. Martineau's M.P. for the Tower Hamlets, Mr. Ritchie, who at his instigation had taken up the subject very warmly and showed great ability in mastering the complicated details. That inquiry was very thorough and lasted two years. There is reason for supposing that they absolutely silenced their opponents, for when the Report came out it was a repetition of their arguments and signed by 17 against five. The five issued a minority report, but said nothing about the points on which they had opposed Mr. Martineau's party during the inquiry. Sir Robert Giffen, as a witness, represented Lord Farrer's views, and did his best to upset the coach, but signally failed. Last year he admitted

that he had been mistaken in opposing the abolition of bounties on that occasion.

The curious thing is that the lucid report of that committee has never been referred to by the statesmen who have discussed the matter since then. Mr. Gladstone's Government succeeded in absolutely quenching it. The sugar question was taken away from the Foreign Office and handed over to the tender mercies of Lord Farrer at the Board of Trade, who succeeded in suppressing it till 1886. Then the refiners were able to breathe again, and the result was the Conferences of 1888-9. But Lord Farrer fought hard and frightened Lord Salisbury's Government to such an extent that they beat a sudden and ignominious retreat.

The rest of Mr. Martineau's career up-to-date will be a fairly familiar one to our readers; but we might refer to the very tardy acknowledgment of his great services to the State and country made last November when he was gazetted a C.B. in connection with the birthday honours. We trust though that this will not be the last honour accorded him, and it is sincerely to be hoped that he will yet live many years to see the practical results accruing from the abolition of the bounties, and, if necessary, to take steps to render them permanent.

NOTES AND COMMENTS.

The Danish West Indies.

After all, the Danish West Indies are to remain in the possession of Denmark. It may be remembered that the United States offered about twenty million kroner for three small islands in the Virgin group. This offer the Danish Government were prepared to accept, and their Lower House endorsed the decision; but the Upper House was opposed to the sale, and after a long and close struggle, the project was finally abandoned. It now remained to make an effort to develop the resources of the islands they had decided to retain. With that object in view, a Commission of four was sent out to the West Indies to formulate proposals for improving the economic conditions of the islands, the low prices obtained for their sugar having severely damaged them. The Commission returned from its tour, and issued its report about a month ago. All four members express the belief that by administrative reforms financial stability can be re-established in the islands. They propose that preferential treatment should be accorded to Danish West Indian sugar in Denmark, so far as the provisions of the Brussels Convention will allow. Danish farmers have already bought up some of the sugar plantations, and with a view to improving the connection with the mother country, it is proposed to substitute the Danish coinage for

the American. The Commission also propose that the islands should be represented in the Danish Parliament.

Confectioners' Grievances.

It was not to be expected that the confectioners would allow the Sugar Convention Bill to pass through Parliament without strenuous endeavours to bring about its defeat. Their mouthpiece, Mr. Lough, made the most of his opportunities, but naturally failed to gain his object. Now, apparently, the public are to be made the scapegoat. They are to be fined, because the confectioners can no longer make such large profits as they did a year or two back. Eighty-eight per cent. beet is at present about 8s. 6d. as compared with 6s. a year ago, 8s. in 1901, and 11s. 6d. in 1900. Between September, 1900, and July, 1902, we do not find any reduction in the price of their wares on the part of the confectioners, although the price of sugar fell 5s. 6d. during that period. But now, when a rise of 2s. 6d. has taken place, they must needs increase the cost of their goods by 2s. per cwt.; and when it is borne in mind that the sugar used in their present goods was bought under the old conditions, at prices ruling months ago, their action seems all the more unreasonable. They may, however, overdo the thing; for at a not very distant date German and French confectionery may make an entry into our markets, and it may be taken for granted that their price will not be ruled by fictitious increases in the cost of sugar used in their manufacture. The Continental manufacturers will base prices on the actual cost, and will give away as much as they can in order to secure the market. Another hubbub which has been raised is over the omission in the Sugar Bill to prohibit the entry of bounty-fed "sugared goods." The agitators might first have ascertained if there were any. They would then have seen that their fears were groundless. But apart from this, a perusal of Art. I. of the Brussels Convention (see *I. S. J.*, Vol. IV., p. 172) will show that such goods are considered to be included in the term "sugar," and are liable to the same penalties.

British Refining.

Since the 1st September the British refining industry has been carried out in bond under the supervision of Customs officers. There are at present 15 firms concerned, but owing to the fact that very large quantities of raw sugar were imported during August (which are refined under the old conditions) very little change in the routine is so far noticeable, and this will continue till all the old stocks are worked off. The refineries will now lose the profit they hitherto reaped through differences in the duties of raw and refined sugar respectively. The drawback on molasses of 1/- per cwt. will also cease; £16,000 is stated to have been paid under this head last year.

French Possessions in the South Pacific.

Sugar fulfilling the conditions laid down by the Brussels Convention—

		Frs.	Cts.
Refined and similar sugars ..	100 kilogs.	6	00
Other	100 kilogs of refined	5	50
Other sugar—			
Refined	100 kilogs.	25	00
Raw	,,	30	00

In such of the French Colonies, other than Martinique and Indo-China, as are subject to the French Metropolitan Tariff (with exceptions), the Customs duties on sugar will be the same as those in force in France, whilst in those Colonies having a special tariff *régime* (other than the French Possessions in the South Pacific) the Customs duties will continue unaltered.

Belgium.—The *Moniteur Belge* for the 26th August contains the text of the new Belgian Sugar Law, which came into operation on the 1st instant.

The rates of import duty fixed by the new law are as follows:—

	Per 100 kilogs. Frs.	Cts.
Juices and raw cane or beet sugars	20*	00
Refined sugars	20*	00
Syrups and molasses produced in the manufacture or refining of sugar:		
Of a total saccharine richness not exceeding 50 per cent.	10	00
Ditto, ditto, exceeding 50 per cent.	15	00

Over and above the duties mentioned, the Government are authorised to impose a surtax on imported sugars, at a rate not to exceed 5 frs. 50 cts. per 100 kilogs.

	Per 100 kilogs, Frs.	Cts.
Preparations of cocoa	30	00
Articles of food containing sugar:		
Containing 20 per cent. of sugar or less	12	00
,, more than 20 but not more than 50 per cent. of sugar	20	00
Containing more than 50 per cent. of sugar† ..	30	00
Beetroots	Free	

The importation, manufacture, sale, transport, or possession of saccharin or similar substances, and of products containing saccharin or similar substances, is forbidden under heavy penalties.

* The import duty of 20 francs per 100 kilogs. imposed on juices and on raw or refined sugars will be reduced to 15 francs on the 1st January, 1907, if the rate of 20 francs is not in the meantime confirmed by fresh legislation.

† The following articles are included under this heading without regard to their saccharine richness: sweetmeats, maccaroons, marzipane, nougat, cakes and other preparations containing almonds and sugar; artificial honey; substances intended for the colouring of beer or spirits.

The *Moniteur Belge* for the 29th August contains the text of a decree imposing a surtax of 5 frs. 50 cents. per 100 kilogs. on raw cane or beet sugar and on refined sugar imported from abroad, in accordance with the above-mentioned provision of the new Sugar Law.

Austria-Hungary.—The Board of Trade have received, through the Foreign Office, a translation of a Ministerial Decree, dated the 26th August, modifying the rates of duty on sugar imported into Austria-Hungary from the 1st inst., as follows:—

Tariff No.		Per 100 kilogs. fl.	kr.
17.	Raw sugar under 98 per cent. polarisation ..	2	20
18.	Refined sugar, and all sugar of 98 per cent. polarisation and over	2	40
19.	Molasses	6	00

The tare allowance of 11 per cent. hitherto made under Tariff Nos. 19 and 20 for sugar solutions in double casks now applies to all solutions enumerated in Class IV. of the Tariff (*i.e.*, the sugar category).

Raw Sugar under Tariff No. 17 can only be passed after determination of the polarisation of a sample officially taken.

By virtue of Article 4 of the Brussels Sugar Convention, special duties in addition to those prescribed in the Tariff will be levied on all kinds of beet and cane sugar produced in bounty-giving countries.

All foreign sugar imported into Austria-Hungary, whether for consumption, refining or manufacture, must be accompanied by certificates of origin.

Sugar unaccompanied by such certificate will be subjected, in addition to the regular Customs duty, to a special impost assessed according to the highest duty in force at the time.

Bounty-fed sugar in transit will only be admitted under Customs supervision, whether the transit be direct or by means of reloading or deposit in a Customs warehouse.

On the same conditions, other sugar in transit will be admitted without a certificate of origin.

Certificates of origin must be issued by financial authorities specially appointed for the purpose by the Government of the country from which the sugar is imported.

Certificates issued by countries which are parties to the Brussels Convention do not require any consular visa.

The certificates must be issued not later than the day of dispatch from the country of origin.

Certificates of origin lose their validity if in the course of transit sugar should be reloaded in a bounty-giving country, even if such reloading is necessitated by *force majeure*. As an exception to this rule, reloading is permissible in a bounty-giving country provided the sugar proceeds from a country a party to the Convention, and provided such reloading takes place under Customs supervision.

The certificates of origin must state:—

(*a*) The quality and quantity of the sugar.

(*b*) The number and description of packages.

(*c*) The origin and destination of the sugar.

(*d*) The method of transport (rail, sea, &c.)

(*e*) For how long the certificate holds good (maximum period—one year, exclusive of detention in Customs warehouses).

Certificates for sugar produced in countries not parties to the Brussels Convention must further state whether the consignment proceeds from a factory which does not refine sugar.

ECONOMIC FALLACIES IN HIGH PLACES.

A complete review of the debate on the Sugar Convention Bill would give a curious picture of the science of Political Economy as seen through the spectacles of party politics. These political men of science despise facts, cast accuracy to the winds and leave the rudiments of logic behind them. Space will not permit us to make a full examination of the misstatements, erroneous assumptions and ridiculous inferences which pervade the speeches not only of the smaller fry but even of the more shining lights of the party political world. Leaving the former to be dealt with by others, let us see what can be said by men of real authority and position in opposition to the policy of the Government.

Sir John Gorst was the first of the big guns to enter the field. His quiet incisive style sounded to the outsider absolutely conclusive, and yet it is impossible to find a single accurate assertion in his speech. The West Indies, he thinks, are to gain nothing if there is no rise in price. He is unaware that the injury to the West Indies caused by bounties is the periodical and temporary over-production of sugar which forces prices down to a level with which natural producers cannot compete, and that this is necessarily followed by reduced supplies and an abnormal rise in prices. He ignores the fact that when bounties are abolished we shall have sugar at its natural price, the only price which will bring no injury to the consumer. The bounties disturb prices and therefore disturb trade, but he asserts that though the abolition of bounties does not necessarily destroy trade it disturbs it, and he regrets that sugar at its natural free trade price should check the development and prosperity of a big trade. The abolition of bounties is, he says, the making of fiscal arrangements to the disturbance of trade.

Mr. Bryce fails to see how the consumer can benefit by having an article at its natural price, instead of having it occasionally below cost price and thus losing the benefit of free competition, paying an excessively high price when natural producers reduce their output,

and eventually becoming dependent on a monopoly. The monopoly he denies, because he says that Germany was from the first "willing to bring its legislation into conformity with that of other countries." Quite so, but Germany could not and would not do so unless we gave her security that we would not permit bounties to compete with her in future. "The Bill," he says, "is, as a matter of fact, promoted by protectionists." A bounty is protection to foreign producers in British markets. We abolish bounties, we refuse to tolerate them, and Mr. Bryce says we are protectionists. We ask for sugar at its natural price with every source of supply freely open; we say we are on those terms prepared to face the competition of the world and let the fittest survive, and Mr. Bryce says we are protectionists. Is this Economic Science or party politics? The Convention compels every country to reduce its surtax,—in some cases to less than a quarter of what it was before—and Mr. Bryce says it is a set back to Free Trade because it "establishes a surtax," and he adds that the cartels will be just as able to raise prices, just as able to dump goods in this country as they have been hitherto. Mr. Bryce has a reputation to lose, as a man of science and of accuracy, but party feeling is too strong for him. But a more extraordinary assertion followed. "All that 'dumping' means is that somebody is kind enough to give us goods below the cost of production. Is there anything to resent in that? Is it any injury to the trade of this country? Has it ever been so? Never." If Mr. Bryce and the rest of his party mean to defend free trade by such arguments as these we fear they will be ignominiously beaten. Such dumping as he describes injures not only the British producer but also the British consumer, and we defy any party free-trader to disprove that fundamental doctrine.

These being the only men of any reputation so far as the House of Commons is concerned, let us turn to the other House. Undoubtedly Lord Welby is the most distinguished person among our opponents, being an expert on fiscal matters of the very highest official position, and yet it is difficult to discover his merits when reading his speech in the House of Lords. If France and Germany "choose to be so silly as to give us a large tribute he does not see why we should not benefit by it." In the first place this fallacy assumes that the bounty is a tribute to us. It is nothing of the kind. The bounty causes more sugar to be produced than the world can consume, and then the price goes down. Secondly, the fallacy assumes that it is a benefit to us that this should take place, whereas it is clearly an injury both to producer and consumer. Lord Welby declares that the Convention "does not promote consumption, because it is perfectly evident that if you restrict trade, if you raise prices, the only effect of that must be to check consumption." The reply is clear. First, the Convention does not restrict trade or raise prices. On the contrary, it frees trade and restores the price of free competition. Secondly, it compels the

reduction of the import duties and enables the foreign countries to reduce also their excise duties. The result is as follows:—

Prices of sugar before and after 1st September, 1903.

	Before.	After.	
France	95 ..	59	francs per 100 k.
Germany	74·25 ..	51·75	,, ,, ,,
Austria	89·75 ..	76·10	,, ,, ,,
Belgium . ..	85 ..	54	,, ,, ,,

This is a pretty bad mistake for an expert to make. It is clear from these figures that there will be a great increase in the consumption of sugar.

Lord Welby disputes the statement that when bounties are abolished capital will flow into the West Indies and set the sugar industry on its legs again, and in doing so he says that if 10s. per cwt. is to have this happy effect why did it not do so ten or fifteen years ago when the price of sugar was 10s., 20s., and even 25s. per cwt.? We are much obliged to Lord Welby for this admission as to prices, which will come in useful presently. He fails to see that capitalists are sensible people and will not risk their money in an industry which stands to be shot at by a constant succession of periods of overproduction caused by bounties, followed by great depression in the industry and a great rise in price.

Lord Welby speaks of the confectioners and jam makers as "those great trades which have risen up under the bounty system, and which will be in danger by the new system." If this were true it would be the very strongest argument in favour of the Convention, because it is absolute cruelty to allow "a great trade" to grow up and increase by leaps and bounds, dependent solely on the will of foreign Governments, who might by a stroke of the pen destroy the whole structure. But fortunately it is not true.

Lord Welby admits "that the import of refined sugar from abroad has risen immensely—from 200,000 tons to nearly 900,000 tons—in recent years, but what has been the result of that? It has enabled the very large industries of the jam trade to flourish during the last twenty years to an extent that will almost beat any other trade in the United Kingdom." He does not explain what difference it would have made to "the very large industries" if the 900,000 tons of refined sugar had been refined in this country, but he adds "it is this large increase of bounty-fed sugar, with cheap rates, which has enabled this immense number of people to be employed." He evidently thinks there are two prices for sugar in the same market, one bounty-fed and the other not. For an expert this is a curious mistake to make. The British refiner would have let "the very large industries" have refined sugar just as cheap 'within 3d. per cwt., because he buys raw sugar just as cheap as his foreign competitor

does. It was only the little 3d. that made the difference, no difference practically to the consumer but a difference of £25,000 a year to a large refiner.

"The best policy," Lord Welby says, "is, as far as possible, to leave trade to its own free and unimpeded course." That is what bounties prevent and what the Convention effects.

He seems to think that the imports of sugar into this country have increased owing to the bounty system; but he does not explain why they should not have increased as much and even more under a system of free and open competition.

In his peroration he lays great stress on the great advantage to the large masses of our poorest population that they should "get such an important article of food as sugar at low rates." He had previously stated that a few years ago, in the very thick of the bounty period, prices had been 10s., 20s., and even 25s. per cwt.

This analysis of erroneous economic doctrine could be prolonged indefinitely, but we have said enough to show that economics if dealt with in a party spirit, even by men of high character and competence, run a very good chance of becoming nonsense, and that if sound doctrine is to be preached in the coming struggle it must be in a very different strain to that which has characterised the debate on the Sugar Convention Bill.

THE SUGAR LOSSES IN REFINERY PRACTICE.

By Prof. Dr. E. O. von Lippmann.

At the suggestion of Dr. A. Herzfeld the subject "The Sugar Losses in Refinery Practice" has been made the order of the day in this Congress, and I have undertaken at his request to make the introductory remarks, although it is apparent to me I have nothing particularly fresh to bring to your notice. Having regard to the scantiness of time available, it would be impracticable to undertake a complete résumé of this question from the beginning, and I must therefore content myself with a brief survey of the principal points involved.

To begin with, it must be understood that certain not inconsiderable working losses are at present inavoidable in every refining process, such as deserve this description, *i.e.*, in the production of loaves, cubes, granulated, and other kinds, obtained by working up the raw material, and not merely from the centrifugalling and washing out of the raw sugar. These losses are calculated either by the mass, *i.e.*, the percentage of finished sugar obtained (excluding packing), and the worked up molasses, amount to less than 100; or by the polarisation, *i.e.*, the figure of sugar content in the finished sugar and molasses is less than the sugar content of the raw material. Mass and polarisation

losses are by no means identical, even when (as we shall do here) the simplest case is considered, in other words the sugar content and the polarisation of the raw sugar exactly coincide, so that the sum total of the turning is brought about solely by the sucrose. We would entirely ignore the factor of the so-called yield, for the latter is in practice an entirely hypothetical one, in many cases amounting to an absurd figure on which nevertheless in forgetfulness of this fact, one habitually persists in basing the prices; instead it tends to mislead one in this direction and is utterly senseless from a technical point of view.

According to their nature the losses are partly mechanical and partly chemical. The former are brought about: By the formation of scum when clarifying and by the filtering off of this scummy syrup; by filtration through char; by the pulverisation in the process of grinding; by the spilling and overflowing of masse-cuites; by the sticking of the raw sugar in the sacks, the eating and purloining on the part of the workman; the granting of small overweights at the solicitation of the buyer; and so on. The chemical losses on the other hand are mainly by decomposition.

As to what the sum total of the loss consists of, we cannot lay down any hard and fast rule. The extent of the losses will depend on the one hand on the purity and physical condition of the raw sugar, on the other hand on the kind and quality of the final products turned out, and finally on the installation of the particular factory, and the working arrangements which it renders possible. An appreciable difference is to be looked for according as the sugar to be worked up has a high, or a low, polarisation; has, given even composition, a sharp well-formed grain, or a greasy syrupy appearance; whether the process is begun on fresh, or on stale, material; whether large crystalled loaves and cubes are the object, or else fine grained refined and cubes; whether the intermediate products leave the place partly in the form of qualities of small value or else are all (under increased use of clairce) worked up into loaves and cubes; whether the apparatus performs its task comfortably, or has to be forced; and so on. Since the influence of these factors is still much underestimated by many technicists, by others in some inexplicable manner entirely denied, it appeared here worth while emphasizing their importance.

In order to obtain an approximate view of the extent of these collective losses, lying as they do still within normal limits, we will select a raw sugar of the average quality that is the most prevalent at the present day in many German refineries. Such a sugar shows about 95·5% Pol., 1·8% water, 1·0% ash (A), 1·7% organic matter (O), and is rated with a so-called yield of 90·5%; whereas in reality (under the ratio of A : O = 1 : 1·7) in actual refining in the above sense and without osmose or similar stimulants we can only obtain under the

most favourable circumstances a percentage of 90°, under less favourable ones a still smaller one. If we gain 90% of refined, then, if no further losses occur, there must remain 5·5% of sugar, 1·8% of water, 1·0% ash, and 1·7% of organic matter together with 10% of a molasses whose percential composition would be: 55·0% sugar, 18·0% water, 10% A, and 17% O (quot. = 67). In reality we obtain such molasses neither in such purity and condition (presuming the unalterable proportion of A : O = 1 : 1·7) nor in such quantity; rather it turns out to be, under the above conditions, only about 9%. Its composition is then about 46% sugar, 20% water, 11% ash, and 23% O (quot. 60), and the 9% contain as well 4·14% sugar, 1·8% water, 1·0% A, and 2·06% O. In this case, which is made as simple as possible, since we suppose the obtained products of the water and ash contents to be similar to the original raw sugar, the loss of the masse amounts to 100 − 90 − 9 = 1%; the loss in sugar is however greater, viz., 95·5 − 90 − 4·14 = 1·36%, whilst organic matter has augmented by 0·36%.

In the course of working under the conditions set forth, a total loss of about 1·36% sugar results, and one is inclined to ask what is the best explanation of this. A definite amount is, as above mentioned, to be set down to mechanical loss, the plain cause of which is demonstrable. If we here choose again, in order to obviate any complicated or doubtful calculations, the most transparent case, that of a refinery which works without employing char, then that loss, at least in large establishments, amounts empirically to scarcely more than 0·25%; the remainder of the loss, 1·36 − 0·25 = 1·11% is hence to be accounted a chemical one, *i.e.*, is due to the decomposition of the sugar. One demonstrable result of this decomposition is shown in the existence of an excess of 0·36% organic substance in the molasses; if we do not take into consideration all the possibilities by which the sugar may absorb water so as to resolve itself into an organic substance, and we account for the 0·36% simply as an equivalent of destroyed sucrose, there yet remains 1·11 − 0·36 = 0·75% as so called "undemonstrable chemical loss."

The cause to which this last loss is to be attributed was investigated by me on the strength of my own experiences, and on the basis of the material stored up in the official protocol of the Charlottenburg refining experiments, in a treatise appearing nearly 20 years ago, and I then came to the conclusion that this alleged loss occurred during boiling. This conclusion has since become known in general as entirely correct, and if now and then in view of the known boiling experiments of Dr. Herzfeld one is inclined to doubt it, one is falling into a decided error, first, because Herzfeld's experiments were not by any means for the purpose of following the variations of clairces of so highly concentrated a purity; and secondly, because they were carried out by means of a digestor heated by oil whereby, as Herzfeld

himself discovered later, the decomposition could be reduced tenfold as compared with boiling by steam at say 130°C.

Much as refining processes have altered during the last two decades, the need still remains, where real refining work is desired, to boil and boil over again, though possibly not to the same extent as was formerly the case. Whereas 20 years ago it was not uncommon when working up the whole product into loaves and cubes for the collective amount of masse-cuite boiled up in the course of a campaign to reach 5 or 5½ times the weight of the raw sugar used; now the same task is accomplished with about 2 or 2¼, at the most 2½, times the amount of the raw sugar. But inasmuch, as the crystallization in pans was given up or else reduced as much as possible, the largest part of the decomposition in this branch of working was suppressed, though, as a matter of fact, under normal conditions this loss was relatively small (amounting at the most to 0·1% calculated in raw); consequently one has the right to place the ever present decompositions to the credit of the boiling process.

Now if for example, as above stated, the chemical loss amounts in round figures to 1·11%, then, when the 2, 2¼, or 2½ fold raw sugar weight of the masse-cuite is boiled, at each working up 0·55, 0·49, and 0·44% respectively will be accounted for; if one adds to the sum the cent. per cent. of the further working up of the masse-cuite then in the boiling proper in the main 0·4 to 0·5% loss occurs. So far as products, such as loaves and cubes, are concerned, which must be fully boiled and filled out at a high temperature in order to retain their hardness and firmness, it makes within certain limits very little difference whether one boils with direct super-heated or with waste steam, because in the last case the advantages of a lower temperature of the heating surfaces is pretty well balanced by the disadvantage of the longer duration of contact. The amount of 0·4 to 0·5% is somewhat higher than the average I met with 20 years ago, which was one of 0·3 to 0·4%; perhaps the altered composition of the raw sugar plays a part here, for the quality of non-sugar present has in some degree an influence on the extent and intensity of the decomposition which occurs; yet it must be observed that already at that time many single experiments gave the same figures, 0·4 to 0·5%, so did that of Charlottenburg where pure refined and crystals were turned out. Likewise Pannenko whose boiling experiences were most unusual for large refinery practice, found in 1898 that the sugar destruction attained to 0·49%. In those old days one found all the non-sugar corresponding to the decomposition of the sugar in the char and the sugar-water, and one would then expect, when no char filtration existed, to find it in the molasses; this is however not the case under the above-mentioned conditions, for the molasses contain, as already mentioned, an excess of at the most 0·36% organic substance equivalent in a boiling to 0·14 to 0·18% (0·16 mean). If we subtract

this 0·16 % from the amount of 0·4 to 0·5 % there yet remains a difference of 0·24 to 0·34 or a mean of 0·3 % which is set down as "unaccountable chemical loss."

What views are we to form in the case cited on the supposed disappearance of this 0·3 %? To my mind there is but one possible explanation. The destruction in the boiling is not confined to the passing over of sugars into stable non-sugar substances (existing as these do in the syrups and masse-cuites), but the solutions of non-sugar present become themselves decomposed, whereby considerable amounts of volatile combinations occur, which escape in the ammoniacal gases and the condensation water. Their analytical separation is admittedly out of question; for any particular working up 1 dzr. of raw sugar gives roughly 1·1 dz. of masse-cuite corresponding to about 1·66 dz. of clairce of 60° Brix out of a mean 30 %, of which 0·49 dz., as water, has to be evaporated. If we employ for precipitation only its twentyfold weight in water, we obtain as much as $0{\cdot}49 + 9{\cdot}80 = 10{\cdot}29$ dz. of condensation water. The 0·3 % chemical loss only accounts for ·0045 of the condensation water: thus no accurate *quantitative* estimation is possible. *Qualitatively*, on the other hand, the existence of the combination mentioned is best established if one taps the outflow pipe as high up as possible, just by the condenser, drawing out the vapour by means of an aspirator and forcing this in a suitable manner through different filtering mediums. If this is done for some time, one succeeds in isolating besides the carbonic acid, a small quantity of organic substance, nevertheless containing enough for recognition. This shows in a high degree the characteristic smell of condensation water, and contains amongst other matters, furol, furan derivates, acetone, and formic and acetic acids. All these substances have long been known as products of the destruction and dry distillation of sugar, and it is noteworthy that the acetic acid which predominates forms also, according to Herzfeld's latest experiments, the principle constituent of the volatile acids in molasses. It is not improbable that this acid, whose origin was till lately little known, owes its appearance to known decompositions in concentrated sugar solutions, which are all the more likely to occur if, as Michaelis knew as far back as 1850, they are heated in alkaline condition and in the presence of metals (principally iron) or their combinations.

In this connection it may be remarked that the decomposition of the cane sugar in the boiling of concentrated solutions is by no means dependent on the presence of invert sugar, but can very well occur through the presence of substances which bear the character of the so-called "products of overheating"; it has long been known and Dr. Herzfeld has more recently accentuated the fact, that the products of refining give according to the analyses of Clerget differences more and more enhanced from those found by direct polarisation, differences which are not explained by the presence of levo-rotatory invert sugar,

but only through dextro-rotatory ones, whose nature lies between sugar and caramel. If one expects, too, to find the measure of the sugar decomposition in terms of the invert sugar, and estimates therefrom the reducing powers of the masse-cuites, syrups, &c., one will arrive, as a general rule, at completely erroneous deductions and conclusions. It may even happen, in practice, when boiling after-products for example, that an increase in the decompositions corresponds to a decrease in the reducing power.

As one sees, the question of the size and nature of sugar losses in refinery practice, even if confined to the simplest conditions, leads to very complicated results, which are by no means to be anticipated *a priori*, and one is still far from having reached a safe and reliable solution applicable to all cases. The principles laid down here appear to me sufficiently established; at all events I am at a loss to understand how those writers who, for example, contest the fact of decomposition during boiling, are going to explain the real undeniable loss and where they will search for its cause. This is, of course, always providing a normal working up be followed and normal raw material be used; for as soon as we begin to treat raw or crystallised sugar which contains invert sugar, very complicated phenomena arise. Descriptions of them will be found in last year's reports of Wassilieff and Neuronoff with regard to refining processes in Russian factories and contain much information of remarkable interest, but they only refer to particular circumstances; one cannot in any case generalise them.

FRANCE.

Results of the Campaign of 1902-03.

The number of factories at work during the season, which closed on the 31st August last, was 319, against 332, 334, and 339 respectively during the three preceding seasons.

The quantity of beets worked up was 6,266,946 metric tons, against 9,350,852 in 1901-02, and 8,717,439 in 1900-01.

The sugar production (in refined sugar value) is calculated at 776,158 metric tons, against 1,051,931 in 1901-02, and 1,040,294 in 1900-01.

The yields (also in refined value) obtained during the past four seasons were—in percentage of the weight of beets:—

	Per cent.		Per cent.
1902-03	12·38	1900-01	11·93
1901-02	11·24	1899-1900	11·75

One result of the lowering of the surtax in Germany has been the entry of 8,000 tons of Belgian sugar into that country.

FOURTH SESSION OF THE INTERNATIONAL COMMISSION FOR UNIFORM METHODS OF SUGAR ANALYSIS.

Held in Berlin, Germany, June 4th, 1903.

The following were present:—

Professor Dr. A. Herzfeld, Chairman.

Privy Councillor, Professor Dr. Landolt, Berlin.

Baron von Donner, Chairman of the *Verein der am Zuckerhandel betheiligten Firmen*, Hamburg.

Privy Councillor Koenig, Chairman of the Board of Directors of the *Verein der Deutschen Zuckerindustrie*, Berlin.

Professor Dr. Brodhun, Representative of the *Physikalisch-Technische Reichsanstalt*, Berlin.

Professor Dr. Shoenrock, *idem*, Berlin.

Privy Councillor Professor Dr. von Buchka, Delegate of the *Kaiserliche Reichsschatzamt*, Berlin.

Government Councillor Weinstein, Representative of the *Kaiserliche Normal Aichungsamt*, Berlin.

Government Councillor F. Strohmer, Vienna, Austria.

J. Ragot, Director of the *Syndicat des fabricants de sucre de France*.

K. Fischmann, Director of the Russian Sugar Manufacturers' Association, Kiev.

Dr. Raschkowitsch, Director of the chemical laboratory of the Russian Sugar Manufacturers' Association, Kiev.

François Sachs, Representative of the *Société Technique et Chimique de Sucrerie de Belgique*, Brussels.

Dr. F. G. Wiechmann, Representative of the American Sugar Refining Company, New York.

E. Silz, Representative of the *Association des Chimistes de Sucrerie et de distillerie de France*, Paris.

A. Watt, Member of the Beetroot Sugar Association of Lancashire, Liverpool, England.

S. Stein, Member of the Beetroot Sugar Association of Lancashire, Liverpool, England.

Also the following Members of the Commission:—

Dr. C. Ahrens, Hamburg; Lobry de Bruyn, Amsterdam; Professor Dr. Frühling, Braunschweig; Dr. G. Götting, Breslau; Dr. B. Hermann, Hamburg; F. Herles, Prague; Dr. A. Langfurth, Altona; Dr. O. Wendel, Madgeburg; Dr. R. Woy, Breslau; as well as numerous other chemists connected with the sugar industry.

After the opening of the session the Chairman expressed his special thanks to Privy Councillor Landolt, the scientific founder of the polariscopic method, as well as to Baron von Donner, and to Privy

Councillor Koenig. for their coming. The Chairman then outlined the previous work of the Commission.

He requested Mr. François Sachs, of Brussels, and Dr. F. G. Wiechmann, of New York, to again undertake the editing of the French and of the English text of the proceedings.

The sets of quartz plates which had been selected by the *Physikalisch-Technische Reichsanstalt* in *Berlin*, and which had been tested in the laboratory of the *Verein der Deutschen Zuckerindustrie* as to their sugar value, have been distributed to proper central stations of the countries interested, and there are kept at the disposal of chemists. These plates have been tested in almost all of the countries which have received the sets, and have been found correct. Some of these stations have thus far not made a report as to the results of this re-examination, and such a report is therefore requested.

Execution of the Paris agreement, according to which chemically pure sugar is to be used for the adjustment of polariscopes and for the testing of plates, has, in some countries, met with difficulties because they could not succeed in preparing chemically pure sugar. The laboratory at Berlin, therefore, offers to furnish chemically pure sugar.

In the determination of invert-sugar a difficulty has arisen, inasmuch as the English chemists have of late again declared against the clarification with basic lead acetate; the Commission will therefore have to seek means and methods to prevent, in this respect, loss of uniformity, now secured in the methods of analysis.

THE DAY'S PROCEEDINGS.

I. "Report concerning practical experiences made with the uniform methods of analysis agreed upon in Paris."

Doctor Hermann delivered an address on this topic; this is published in the *Zeitschrift des Vereins der Deutschen Zuckerindustrie*. The speaker was of the opinion that numerical proofs of the success of the Paris agreement could not be adduced, yet the fact could be stated that the differences have decreased in number. To avoid a warming of the polariscope tubes in handling, he recommended covering the same with rubber.

Privy Councillor Professor Doctor von Buchka made the following statements:—

The International Commission for Uniform Methods of Sugar Analysis decided in the year 1900 that the determination of invert-sugar in raw sugars is to be carried out according to the method of Professor Dr. A. Herzfeld. It seems desirable to abandon this method and to prepare Fehling's solution in such a manner that the weighed constituents be brought into solution with water, up to one liter. This would be in accordance with the method otherwise customary in the preparation of normal solutions. This method of procedure has, moreover, been adopted in the official directions for

the analysis of wine, decreed in Germany in the year 1896. It seems desirable that the manner of preparing Fehling's solution be always the same, whatever purpose the sugar determination may have to serve.

Professor Dr. Herzfeld replied that Herzfeld's method differs from the method used in the examination of wines, not only in the manner of preparing Fehling's solution, but also in the employment of a definite heating surface. A further essential difference is the fact that the reaction is suddenly interrupted after two minutes by the introduction of cold water. On this account all tables which have been prepared by Meissl and others are no longer of value, unless one is also willing to return not only to Soxhlet's Fehling's solution, but also to the antiquated working methods for which these tables have been established.

In the determination of invert-sugar the ten grams of cane sugar which are dissolved in Fehling's solution exert a great influence on the amount of copper reduced. It would therefore be dangerous to alter the concentration of the solution before this influence shall have been carefully studied, and a decision arrived at as to whether it might not be necessary to establish a new table for the solutions made thus differently.

Mr. Pellet declares himself as opposed to the use of basic lead acetate as a clarifying reagent, and for the heating of the solution to reduce the copper on the water-bath instead of over the naked flame.

Government-Councillor Strohmer believed that he might declare in the name of the Austrian chemists that they agree with the remarks made by Professor Herzfeld, for a change in the manner of preparing Fehling's solution would necessitate a change of tables for the determination of invert-sugar, that is to say, would amount to a change of the method itself. Commerce has adopted Herzfeld's method. Each produce-exchange demands in the certificate determination of invert-sugar according to Herzfeld. If the method were to be changed the consent of commerce would have to be secured. It was the determination of invert-sugar which held back for so long the introduction of uniform methods, and Mr. Strohmer expresses the wish that this agreement, which it was so difficult to bring about, may not again be disturbed so soon by the introduction of a new method of preparing Fehling's solution. Dr. Woy next presented an additional report *(ad. 1.)* of the day's program. He, too, is unable to present data which cover all Germany, but in a compilation of Silesian analyses made in duplicate he made the observation that series of analyses which were in excellent agreement were suddenly interrupted by series which exhibited serious differences, and that in such cases the super-analysis also did not tally with the series of former analyses, but at times represented an accurate average. In such cases only the samples can have been the cause of the differences.

He recommends the collecting of such cases in order to determine numerically how often greater differences arise and whether in such cases the fault is to be ascribed to the method, the analyst, or the taking of the sample. Furthermore, he desires a more exact definition of the maximum amount of basic lead acetate, and of aluminium hydrate, allowable, in order to exclude as far as possible the source of error inherent in the volume of the precipitate.

Dr. Koehler-Maltsch was of the opinion that differences which still occur in polarizations must be ascribed to faulty graduation of the flasks.

The Commission decided to elect a Sub-commission for the elucidation of the questions at issue. This Sub-commission is to consist of Messrs. Watt, Wiechmann and Strohmer, and is to study especially the question of clarification by basic lead acetate, as well as the question of a change in Fehling's solution. Privy-Councillor von Buchka promises his assistance in these investigations.

II. "The valuation of 'Sand' and 'Krystallzucker' in International trade."

Government-Councillor Strohmer, of Vienna, discussed this question. His lecture is printed in the *Zeitschrift des Vereins der Deutschen Zuckerindustrie.* This address evoked no discussion.

III. "Introduction of International uniform directions for sampling raw sugars." Mr. Wiechmann stated that he considered it to be very desirable that a 100 per cent. sample be taken, that is to say, a sample from every package wherever this may prove at all possible. Furthermore, he added that great attention ought to be paid to the manner in which samples are taken, for otherwise very peculiar results would be secured, especially with the raw sugars of lower grades.

Director S. Stein, of Liverpool, explained that in England sugar, on importation, has to pay duty according to polarization. It is of great importance that for this purpose the same sample be used which is used in effecting the purchase. The English authorities found very marked differences between their analyses and the results which the refineries declared. The cause of this is to be sought in the different manner of sampling of the sugar. It is very difficult to obtain a correct average sample, especially of cane sugar. As is known, cane sugar is put up in different kinds of packages. For instance, in bags, in mats, in hogsheads, etc. Furthermore, a cane sugar is not homogeneous, but varies in composition in different parts of the package. Thus, in cane sugar, syrups and semi-fluid masses occur. All this has to be taken into consideration. It is necessary that the sampling be done in such a manner that the sample drawn be truly representative of the sugar. Sampling should be done

in such a way that the sample shall be taken from different parts of the package, and at one time. It is well known that stored sugar changes its composition. A sugar which has a certain composition to-day has a different composition one or two months hence. It is also necessary that the sampling be done on a given number of bags or packages. Mr. Stein therefore advised the adoption of a resolution or the addressing of a request to the International Commission to consider what points of view should necessarily be borne in mind in order that uniform sampling, especially of cane sugars, may be achieved. The speaker is confident that the conclusions of such a forum in this most important matter would prove binding and elucidating.

At the request of the chairman Mr. Wiechmann agreed to prepare a compilation of the different directions which are in force in the various countries interested in the sugar industry, and to submit this preliminary report to the Sub-commission, consisting of Messrs. Wiechmann, Watt and Strohmer.

It was the general opinion that it was necessary to consult expert chemists more than has been done heretofore in the drawing up of working directions for samplers.

IV. and V. "Influence of temperature on the specific rotation of sucrose," and "Introduction of temperature-corrections when the temperature of observation differs from the temperature of 20° C., which has been accepted as the normal temperature." These two topics are disposed of together.

Dr. Schoenrock discussed the first-named of these subjects. His address is printed in the *Zeitschrift des Vereins der Deutschen Zuckerindustrie.*

In the discussion of this address Mr. Wiechmann, while expressing appreciation of Schoenrock's labors, declared against the introduction of corrections to polarizations obtained in actual practice. Professor Herzfeld took the same position, because, besides the variations in specific rotation, still other factors come into play, for instance, the variable amount of evaporation which takes place on filtering the solution.

Professor Brodhun remarked that if correct corrections are applied correct results must be obtained. It was decided that the individual members of the Commission for the present are to study the question of corrections on their own account.

VI. "Determination of the sugar subject to duty or bounty contained in saccharine products and fruit preserves."

In this connection the chairman read a paper prepared by Mr. H. W. Wiley of Washington, who, to the regret of those assembled, was

prevented from attending. The chairman closed his remarks with the words that the point of view taken by Mr. Wiley would probably meet with the unanimous approval of the Commission. There was no objection to this comment.

VII. "Chemical control as an aid to the Entrepôtsystem, sanctioned by the Brussels convention."

The printed address of Professor Herzfeld on this subject was in evidence. It also appeared in the *Vereinszeitschrift.* There was no debate on this address.

The following papers which figured on the program of the Congress of Applied Chemistry were also disposed of during the session of the Commission:

(1) Lecture of Mr. Wiechmann on "A restant source of error in optical sugar analysis." The question of the influence of the basic lead acetate precipitate, discussed by Mr. Wiechmann, is to be further studied.

(2) Lecture of Mr. Dupont: "Sur l' unification des échelles saccharimétriques et l'adoption d'une échelle á poids normale de 20 grammes."

Mr. Dupont was not present. Decision on his proposition to introduce a normal weight of 20 grammes is deferred.

(3 and 4) A paper by Mr. David R. Davoll: "A study in the determination of raffinose," and a paper by the same, "Should raffinose be considered as non-sugar in calculating the quotient of purity?" were presented in print. There was no discussion of these papers.

(5) A lecture by Mr. Sachs: "Shall chemical measuring instruments be graduated according to the old Mohr method, or according to the new official method of France and Germany?" A discussion followed this address. Professor Weinstein and Privy-Councillor von Buchka stated their opinion to be that a single section should not adopt a resolution in this matter, and declared a return to Mohr's method a step backwards. Mr. François Sachs disputed the latter assertion.

The meeting then adjourned.

F. G. WIECHMANN.

The retail price of sugar in France has gone down at least $1\frac{3}{4}$d. per lb. This speaks well for the chances of stimulating consumption in that country. German buyers have secured a reduction from 29s. 6d. to 20s. 9d.

THE CHEMICAL NATURE OF THE PRODUCTS OF OVERHEATING OF SUGAR.

By F. Stolle.

(Read at the International Congress for Applied Chemistry, Berlin.)

The fact that in the manufacture of sugar appreciable amounts of the same get destroyed, has forced us not only to study the question from a scientific standpoint, but also to improve the apparatus used in the industry on the basis of strict experimentation and deliberation in order to reduce the loss to a minimum.

The sugar losses from which a refinery suffers are of three kinds; there is first of all the mechanical loss which accrues from working up the sugar; secondly, the loss caused by the chemical impurities found in the raw material; and thirdly transformations in the sucrose itself, brought about by the method of working employed, such as inversion and caramelization.

We have long held the view that there are no longer any so-called undeterminable losses in our industry; we are convinced that each of the phases of manufacture through which the sugar passes exercises a greater or lesser influence in destroying it. But so far no reliable scientific explanation of this fact has been forthcoming, and it is not possible at the moment to suggest an entirely satisfactory solution.

The worst enemy of sugar is unquestionably heat. We know that in all those phases of manufacture in which a high temperature is present for an extended period, the sugar suffers more or less appreciable decomposition and transformation, which is recognized either by smell, by taste, or by the naked eye.

That the character and extent of these sugar decompositions arises from chemical combinations in the heated sugar solutions, goes without saying, for it is clear that a chemically pure sugar solution must behave differently to one which contains either alkalies or acids, or their respective salts. In the general trade, it is practically impossible to work with chemically pure sugar, for to begin with we have to deal with raw products which contain foreign organic and inorganic bodies, and for another thing, we are forced to increase the amount of inorganic matter present by adding alkalies in order to reduce the possibility of the amount of organic non-sugar increasing during the process by means of inversion.

We are thus placed in a dilemma out of which we emerge by choosing the lesser evil, the addition of alkali, in order to avoid the greater inversion. According to the quantity of alkali which is added, we shall have to reckon with invert sugar and products of

decomposition in more or less considerable amounts. If we work so strongly alkaline that the masse cuite is distinctly alkaline to the phenolphtalein test, we shall then have little reducing matter to deal with in the same; but in that case the masse cuite will get a darker shade of colour under the higher temperature than in the contrary case. The residual molasses will not turn out a well flavoured syrup without further treatment. These are the disadvantages of working with a proportionately high alkalinity under high boiling temperature. But if one is in a position to work at a low temperature owing to the product not needing great hardness, then it is advantageous to have a distinct alkalinity as the normal.

These two methods have their *pros* and *cons*, and their application in practice is almost entirely the result of the conclusions drawn by the sugar consumer from the finished wares. Which of these is the most advantageous it is not within the scope of this paper to decide.

I have only touched on these two points in order to compare with one another two works appearing some time ago which treated on the destruction of sugar through heat in the course of large refinery practice. These are the works of Wassilieff and Molenda. The first represents the Russian system, the boiling at high temperatures, whereas Molenda deals with the customary methods in Western Europe. Herein lies the chief reason for the difference in sugar destruction and the amounts of reducing matter arising therefrom.

If we compare the cooling temperature of a strike of refined according to the two authors, we find that Wassilieff gives 102·5° C. and Molenda 90·5°, being a difference of 12° C. How great an influence the height of the temperature has in decomposing these strong concentrations is best seen from Herzfeld's experiments, and to quote a case in practice which has a direct bearing on this refining, Woestyn says that the transformation in the sugar commences at a steam pressure of 2, or even 1½ atmospheres, and becomes more extensive the higher the temperature and pressure are raised during boiling.

Unfortunately Wassilieff gives no intimation of the alkalinity of his juices and masse cuites, and it is also to be noted that all his calculations are on the basis of the apparent purity. We find that the heating up of the strike from 87·5° to 102·5° lasts, according to Wassilieff, 23·5 minutes, while Molenda gives 8 to 10 minutes, and only heats from 76° to 90·5°. In both cases a variation of 15°, but the initial temperatures were very different.

It follows from this that the degree of heat applied during the boiling and also the duration of its action on the masse cuite leads in Wassilieff's cases to greater destruction than do Molenda's at a lower temperature. Moreover, the Russian sugar is boiled coarse, whereas Molenda only deals with fine grain. This difference points in the former to a much slower formation of grain at a higher temperature

than in the other. To mention once more the rôle played by lime, a distinct alkalinity protects the sugar from an otherwise quicker destruction, but it considerably affects at a high temperature the products of decomposition arising therefrom, so that the masse cuite becomes eventually darker.

In any case the two publications cited are of great value, and we must certainly thank Wassilieff for drawing our attention to this momentous matter in our industry.

To go more closely into the estimation of these newly established products of decomposition we must consider whether the establishment of the reducing power alone suffices for elucidating this problem. I believe that I can show that this is not the case; and in proof of this contention we have only to glance at Wassilieff's work, where he has failed to find any sugar loss during boiling, with the copper test.

Bearing in mind the importance of Wassilieff's indications, I instituted similar experiments. I started to begin with from the same point of view, but soon came to the conclusion that all the transactions and decompositions involved were not sufficiently and characteristically estimated by the copper test alone, but that to complete the experiment the following tests were needed as well:—

1. Direct polarisation.
2. Estimation of sugar after Clerget's method.
3. Estimation of the ash.
4. Estimation of the organic non-sugar.
   Organic non-sugar I=100—(P+A).
   ,, ,, ,, II=100—(Clerget+A).

and the water estimation.

With these figures to hand it is possible to get a fairly accurate estimation.

It might be well to point out here that all subsequent figures refer to clairce and masse cuite which were obtained exclusively from pure white Russian raw sugar without the slightest presence of after-products or washing waters. The raw sugar employed came from the 1902-3 campaign, and had an average composition as follows:—

Polarisation	99·75	per cent.
Sugar after Clerget	99·75	,,
Water	0·04	,,
Ash	0·034	,,
Organic non-sugar	0·176	,,

10 gr. sugar reduced 32·5 mgr.; the sugar was thus free from invert sugar.

The raw sugar was melted down in large iron pans of 3·9 cubic metres capacity with warm water, under the action of direct steam at 45lbs. pressure and heated to 90° C. During the melting and heating

the mass was kept in continuous motion by means of a stirrer. The clairce was about 69·70 Brix thick. A very slight addition of lime was made, just sufficient to prevent inversion. The completed solution, which required for neutralization an average of 0·3 cm. of 1·10 normal acid (Phenolphtalcin indicator), gave on analysis the following figures calculated on 100 of dry substance:—

Sugar	99·67 per cent.	10 gr. of sugar solution reduced 46·2 mgr. of copper.
Clerget	99·21 ,,	
Ash..	0·03 ,,	
Organic non-sugar—I	0·30 ,,	
Organic non-sugar—II	0·76 ,,	

Here decomposition has already commenced, as is seen by the altered figures.

The analysis of the clairce filtered over char gave:—

Polarisation	99·85 per cent.	10 gr. of clairce reduced 47·0 mgr. of copper.
Clerget	99·57 ,,	
Ash..	0·02 ,,	
Organic non-sugar—I	0·13 ,,	
Organic non-sugar—II	0·41 ,,	

On comparing the two results we find a decided improvement in the clairce. There is no sensible increase in the amount of copper reduced, the small difference lying within the limits of analytical error.

If we now turn to the boiling mass, we find the following temperatures:—

Concentration of the clairce ..	between	55° and 62·5° C.
Graining	,,	62·5° and 75°.
After-boiling	,,	75° and 94°.
Reheating	,,	94° and 97·5° C.

In order to test the assertion of Wassilieff that the sugar decomposition was distributed unevenly in the loaves in the filling house, a sample of masse cuite was placed in a tin case and quickly cooled. Again a loaf was cut through lengthways and samples taken from the base and apex respectively.

These samples give the following results:—

	Filtered Clairce.	Sample.	Loaf. Top.	Loaf. Centre.
Sugar after Polarisation	99·85	99·76	99·69	99·39
Sugar after Clerget ..	99·57	99·60	99·46	99·25
Ash	0·02	0·02	0·02	0·02
Organic non-sugar—I	0·13	0·22	0·29	0·59
Organic non-sugar—II	0·41	0·38	0·52	0·73
10 gr. reduced mgr. of copper..	47·0	50·7	53·1	61·2

Both the masse cuite and the clairce were here fully neutral.

If we look once more at the figures we shall note that just as in Wassilieff's case an alteration has actually taken place in the composition of the masse cuite, not only the amount of reducing substance, but also the optical figures show clearly that decomposition has been at work. This is further shown in the certain growth of organic non-sugar.

There is, however, a possibility of explaining otherwise the differences in the composition of the loaf masse cuites. The quantity of green syrups present in the masse cuite varies in particular portions of the loaves. In a perpendicular casting the crystals go more rapidly to the point than to the upper end. Consequently the loaf points are richer in crystals and heavier than are the bases. Should then the gentle cooling have no influence on the amount of reducing substance, we can find out from the figures of water content (and consequently of green syrup content) as well as the reducing figures, how high the yield in reducing substance is for any given portion of the sugar loaf. If the moisture in the tested sample is 8·53 per cent., the copper test gives, calculated in dry substance, 50·7 mgr., the water content in the centre of the loaf 9·53 per cent. The supposed yield in reducing substance in proportion to the amount of green syrups is given by the equation

$$8{\cdot}53 \ : \ 50{\cdot}7 \ :: \ 9{\cdot}55 \ : \ x$$

consequently x was calculated at 56·7 mgr. Cu. in dry substance. It was, however, found to be 61·2 mgr. This small difference shows us that really more copper was found; this is also clear from the fact that the polarisation differences were greater than had been calculated. At the same time we also notice that the differences are not so great as they appeared at first sight. It is clearly shown from the figures of Wassilieff and myself that under a high temperature of cooling the decomposition in the sugar extends to the filling house, whereas Molenda's figures prove that at low temperatures such is not the case. In the first method (boiling and cooling at high temperature) the masse cuite is very light coloured to commence with, but is observed on cooling to become darker; here the high temperature has an influence on the colour and on the chemical composition of the masse cuite.

(To be continued.)

The imports of sugar into the United Kingdom during August were very large. A good deal of the increase was due to Russia's desire to get in as much as possible before prohibition intervened.

THE CARBONACEOUS MATTER OF ANIMAL CHARCOAL.*

By T. L. Patterson, F.I.C., F.C.S.

(Continued from page 433.)

Analyses of Typical Charcoals.—Having separated and determined the composition of the carbonaceous residue from hydrochloric acid and the organic body separated from that residue by cold sulphuric acid, I analysed a number of typical samples of animal charcoal—that is to say, the portion which is lost on ignition—to ascertain any difference amongst them with regard to the organic body and the changes which take place with use. The charcoals were all calculated to dryness at the temperature of the water-oven, and the weights of the carbonaceous and organic matters were determined at the same temperature. The organic matter soluble in water was obtained by washing the charcoal with water, evaporating the filtrate to dryness on the water-bath, and igniting gently. In all cases the residue blackened on ignition. The difference in weight before and after ignition is the soluble organic matter. The organic matter soluble in sulphuric acid was obtained as described above; it is the difference in weight before and after treatment with concentrated sulphuric acid. A portion was ignited, and the weight of the ash recorded. Carbonic acid was estimated in the original charcoal and also in the ash; the difference gives the carbonic acid burned off. Organic matter soluble in hydrochloric acid is the difference between the sum of these constituents calculated to per cent. and 100. Nitrogen was determined by the Kjeldahl process in the whole charcoal and in the carbonaceous residue from hydrochloric acid; that is to say, carbonaceous matter + organic matter. The difference between these two estimations gives the nitrogen soluble in hydrochloric acid. In order to ascertain whether the soluble nitrogen was not due to ammonia or some of its derivatives, a portion of I. was washed with water and the filtrate distilled with soda. Only 0·017 per cent. of nitrogen, existing probably as carbonate of ammonia, was recovered. The residue was then treated with hydrochloric acid and filtered. The filtrate distilled with soda yielded 0·087 per cent. of nitrogen, existing probably as amines. These two estimations only acccount for 0·104 of the 0·51 per cent. of nitrogen soluble in hydrochloric acid; therefore most of the nitrogen soluble in hydrochloric acid exists in combinations which are not volatile. The presence of fixed nitrogenous bodies was demonstrated by evaporating other portions of the aqueous and hydrochloric acid solutions of the same charcoal to dryness with

* From the Journ. Soc. Chem. Industry, Scottish Section.

excess of soda solution. Portions of each residue were heated in a test tube with soda-lime. In each case the vapour given off had the smell of burnt bones, and turned moistened red litmus paper blue. The charcoal contains besides, a trace of nitrogen existing as insoluble cyanides, for, on condensing the gases given off on treatment with hydrochloric acid, hydrocyanic acid was detected, both by smell and by the ferrocyanide test.

A great difference is noticeable in the percentage of carbonaceous matter in these charcoals. I. and II. have been made from bones from which little, if any, of the gelatin was boiled out before charring, like III., IV., and V.; VI. and VII. are stock charcoals from one refinery where the carbonaceous matter increases with use, by the charring of vegetable matter, absorbed from the sugar solutions in the process of revivification. In VIII. the carbonaceous matter has been reduced to about half that in new charcoal by air leakages in the same process; and No. IX., like No. VII., has accumulated carbon, to the extent of about 7½ per cent., in the course of long use.

The organic matter soluble in water is a trifling quantity, but it is present in all new charcoals. Of course the first washing removes it.

The organic matter soluble in sulphuric acid is a significant constituent of animal charcoal. Together with the carbonaceous matter it forms the residue obtained on treatment with hydrochloric acid, usually called carbon. No. V., which only contains 0·27 per cent., has been charred at a higher temperature, and probably for a longer period than the other four new charcoals. The refinery stock charcoals, VI. and VII., have lost a large portion of this organic matter, and the spent charcoals, VIII. and IX., contain little more than a trace. I am inclined to believe that this organic matter plays an important part in the life of the charcoal, as I hope to show after we consider the nitrogen estimations.

The organic matter soluble in hydrochloric acid, although a difference quantity and probably containing a little water, is, too, a significant constituent, as will also appear after discussing nitrogen.

The only other constituent lost on ignition is carbonic acid, and the analyses show the loss to be great in the case of new charcoals. In all the charcoals, except IX., the loss amounts to between 69 per cent. and 94 per cent. of the total carbonic acid present. The stock charcoals lose less because they contain less, and that in proportion to the time they have been in use. The carbonic acid in the spent charcoal has nearly all been burnt off in the process of revivification. The observation of this loss on ignition reveals a considerable error in the analysis of charcoal, which, together with the organic matter soluble in water and in hydrochloric acid, has hitherto been recorded as organic matter.

Discussion of Nitrogen Determinations.—Nitrogen has long been known to be an essential constituent of animal charcoal. Wallace (Proceedings, Glasgow Phil. Soc., Vol. VI., p. 377, 1865-68) gave it as his opinion that the nitrogen is in combination with carbon. With reference to the carbonaceous matter he says: "Although it is always called carbon, it is not strictly pure carbon, but consists partly of that element and partly of nitrogen." And believing that the nitrogen removed by hydrochloric acid was due to decomposition of carbon nitride, recommends that in reporting analyses any such nitrogen should be added to the carbon insoluble in that acid (*Sugar Cane*, Vol. II., p. 505, 1870). He made several estimations of nitrogen, and found 1·08 per cent. and 1·55 per cent. in new charcoal containing 9·00 per cent. and 8·50 per cent. of carbon. He observed that the nitrogen diminished with use, for two samples of moderately old charcoal contained only 0·30 per cent. and 0·55 per cent. of nitrogen. He also observed that the carbonaceous matter separated from a particular sample contained about two-thirds of the nitrogen existing in the original charcoal; in other samples he found much less. And in a paper to the Chemical Society (*Chem. Soc. Jour.*, Vol. XXIII., p. 100, 1869) he mentions having found 0·034 per cent. of hydrogen in a specimen of charcoal, but he did not carry the investigation further. My experiments generally confirm those of Wallace with regard to the total nitrogen in charcoal, its loss on solution and diminution with use, but I have arrived at other conclusions regarding its combinations.

It has been shown above that the carbonaceous matter separated with hydrochloric acid contained 6·38 per cent. of an organic body soluble in cold concentrated sulphuric acid, which yielded to ultimate analysis 11·97 per cent. of nitrogen. On calculating the proportion of this body present in the carbonaceous matter insoluble in hydrochloric acid, that is, carbonaceous matter + organic matter, for the analyses given above, we find that I. contains 9·76 per cent.; II., 12·62 per cent.; III., 17·69 per cent.; IV., 14·89 per cent.; V., 2·60 per cent.; VI., 2·49 per cent.; VII., 2·40 per cent.; VIII., 0·39 per cent.; and IX., 0·23 per cent. The percentage is very high in II., III., and IV., and when we recollect that more of these bodies can be dissolved out by digestion with sulphuric acid at 100° C., and still more on boiling, we are justified in assuming that a large portion of what, in new charcoal, has hitherto been called carbon is composed of highly carbonised nitrogenous bodies. Indeed, it is very probable that elementary carbon does not exist in new charcoal at all, for if we calculate the nitrogen insoluble in hydrochloric acid to its equivalent of the organic body, and deduct the figure so found from the residue insoluble in hydrochloric acid, that is, the carbonaceous matter + organic matter, very little carbon is left to exist in the free state. This has been done in the following table :—

—	N insoluble in H Cl.	Corresponding Quantity of Organic Body=N.	H Cl Residue found. (Carbonaceous Matter+Organic Matter.)	Free (?) Carbon.
I.	1·85	15·45	20·19	4·74
II.	1·75	14·62	16 56	1·94
III.	0·99	8·27	10·74	2·47
IV.	0·84	7·02	11·42	4·40
V.	0·55	4·59	10·40	5·81
VI.	0·67	5·60	11·65	6·05
VII.	0·71	5·93	16·65	10·72
VIII.	0·15	1·25	5·07	3·82
IX.	0·66	5·51	17·09	11·58

The last column shows how much carbon should be present in the free state, if all the nitrogen in the carbonaceous matter were combined as it is in the organic body. Inasmuch, however, as there are several organic bodies present in the carbonaceous matter, and as they are likely to decrease in nitrogen as they become more carbonised and insoluble in sulphuric acid, we are driven to the conclusion that elementary carbon does not exist in new charcoal, but that it is all in combination with nitrogen, hydrogen, and probably oxygen. Of course, this statement does not hold good with old or used charcoals like VI., VII., and IX., in which the carbonaceous matter has increased from the accumulation of vegetable carbon in the process of revivification.

Theoretical Conclusions.—The organic bodies, soluble in acids, doubtless play an important part in the economy of the charcoal. We have seen that they are colour absorbers, and that they decrease with use and revivification, until in the two spent charcoals only traces remain. There are two theories with regard to them which may be put forward to account for the decrease. The first is, that these bodies which are less highly carbonised than the insoluble carbonacous matter, form in the charcoal a kind of reserve, from which a new surface of very active carbonaceous matter is deposited every time the charcoal is revivified; the very low red heat to which it is subjected just being sufficient to produce the carbonisation necessary for the purpose. As long as a portion of these organic bodies are retained the charcoal remains active and capable of exerting its full, or nearly its full, decolorising power. When they are burned out, as in VIII. and IX., the charcoal becomes useless.

The other theory is that these bodies are gradually dissolved out by the large quantities of sugar liquid passed through the charcoal. New charcoal has the property of giving the lower products of the

refinery a rich yellow "bloom," much appreciated by sugar consumers. As the charcoal becomes old this effect wears away. The acid solution of the organic matter separated by sulphuric acid possesses this yellow colour, and the aqueous solution, although colourless at first, undergoes decomposition and becomes yellow with heating and concentration. The hydrochloric acid solution is also colourless, if we except the slight yellow colour due to iron, a little of which is present in all charcoal, and, doubtless, like the aqueous solution, assumes a yellow colour with heating and concentration. This property of instability and becoming coloured on heating, is possessed in a very high degree by all the volatile products of the destructive distillation of bones. In view of these considerations it may be assumed, with little hesitation, that the bloom is produced by solution in minute quantity, in the sugar liquor, of the more soluble portions of the nitrogenous organic bodies in the charcoal. We have seen that the hydrated body is soluble in a solution of sugar, but perhaps both portions—that soluble in hydrochloric acid as well as the portion soluble in sulphuric acid—contribute to the effect. Whatever the quantities dissolved, it will be colourless at first, but the heating it undergoes in the process of boiling the sugar solutions to grain, is sufficient to bring about the slight decomposition necessary to produce the yellow colour, which, like the syrup, is concentrated in the after products of the refinery. A very little would be quite sufficient to communicate the bloom to the yellow sugars. Instead, therefore, of being further carbonised by revivification, they are, according to this theory, slowly consumed by dissolution in the sugar liquors. If it be the case that these bodies are the colour producers, then Charcoal No. V. could not be expected to give much bloom, since it contains less of them than No. VII., which has been 38 weeks in continuous use, and probably revivified 45 times. These, however, are questions which will require careful study in the refinery to arrive at a definite conclusion. One or other of the two theories which I have mentioned may serve to explain what takes place, but both may be required to to account for the gradual fall of organic matter in stock charcoals in the course of long use.

I have to acknowledge the assistance of Dr. Patterson, of the Yorkshire College, who kindly made the combustions for me.

In the South African Customs Union tariff, under Class I., we find the following:—Sugar: (*a*) Not refined, golden syrup, molasses, saccharum, and treacle, 3s. 6d. per 100 lbs.; (*b*) refined, 5s. per 100 lbs. No rebate is granted to sugar from the United Kingdom.

LEVAN: A NEW BACTERIAL GUM FROM SUGAR.*

By R. Greig-Smith, M.Sc., and Thos. Steel, F.L.S., F.C.S.

(Continued from page 452.)

Levan thus prepared is a yellowish-white solid, opaque when dry, and translucent when moist. It dissolves in a small proportion of water to form a mucilage resembling gum arabic, and on the addition of more water the solution becomes white and opalescent. The gum does not separate from the semi-solution when allowed to stand for lengthened periods nor when centrifuged.

Because of the persistent opalescence of the solution, which is not removed by any ordinary means of treatment such as filtration with aluminium hydroxide, &c., it is not easy to determine the specific rotatory power of the gum except in a somewhat dilute solution. A solution containing 1 grm. of crude gum in 100 c.c. of water, when observed in 106 mm. tube in a Polarimetre-Laurent with monochromatic soda flame, gave a reading of—0·39° at 20° C., which is equivalent to a specific rotation of about $[\alpha]_D^{20°}$—40° for the pure gum. After oxidation with nitric acid of 1·24 sp. gr. at 60° C., only oxalic acid was obtained; neither mucic nor saccharic acid was formed.

On treatment with dilute acids in the cold or more quickly on warming, the gum is readily and completely hydrolysed, the sole product being levulose, which is produced in practically the theoretical quantity required by the formula—$C_6H_{10}O_5 + H_2O = C_6H_{12}O_6$. In some respects, this substance resembles Lippmann's levulan, a body found in the juice of beetroots and in the residual molasses produced during the manufacture of sugar therefrom. The most important points of resemblance are in yielding levulose on hydrolysis, and in possessing a lævo-rotatory power. From levulan it chiefly differs, (*a*) in having a much lower specific rotating power, that for levulan being $[\alpha]_D - 221°$, whilst levan is only about $[\alpha]_D - 40°$; (*b*) in giving no blue precipitate with Fehling's solution; (*c*) in the concentrated solution not gelatinising on cooling; (*d*) in not becoming insoluble in water when dehydrated by alcohol; (*e*) in not being precipitated by lead subacetate.

In his original description (Ber., 14, 1509), Lippmann stated that levulan yielded mucic acid on oxidation with nitric acid, and this statement has been copied into standard works (Thorp, Dict. Applied Chemistry, ii., 280, 1891; Morley and Muir, Watt's Dict. of Chemistry, iii., 116, 1892; Allen, Commercial Organic Analysis, i., 423, 1898). Lippmann (Ber., 25, 3320, 1892) subsequently corrected the statement, having found it to be erroneous.

* From Journ. Soc. Chem. Industry.

In the following table the properties of levan are compared with those of the allied substances inulin and starch :—

	LEVAN.	INULIN.	STARCH.
$[\alpha]_D$	— 40°	— 40°	Strongly dextro-rotary.
Oxidation Nitric Acid	Oxalic Acid; no Mucic Acid	Oxalic Acid; no Mucic Acid	Oxalic Acid; no Mucic Acid
Cold water	Very soluble	Sparingly soluble	Insoluble.
Hot water solution after cooling	Mucilaginous	Limpid.. ..	Gelatinous.
Prolonged heating with water at 100° C.	Unchanged..	Hydrolised to Levulose	Unchanged
Hydrolysis with acid	Levulose....	Levulose....	Dextrose, &c.
Baryta water	Precipitate..	Precipitate ..	Precipitate.
Lime water	*No precipitate	No precipitate	Precipitate.
Milk of Lime	Precipitated.	Not precipitated	Precipitated.
Strontia water	Precipitated.	†	Precipitated.
Lead Subacetate	No precipitate	No precipitate	Precipitate.
Ammoniacal Lead Acetate	Precipitate..	Precipitate..	Precipitate.
Action of solution on Lead Oxide in cold	Does not dissolve PbO.	Dissolves PbO.	Does not dissolve PbO.
Ammoniacal Silver Nitrate in dark	Not reduced.	Reduced	Not reduced.
Boiling Fehling's Cu solution..	No reduction	Slowly reduced.	No reduction
Iodine	No action ..	No action ..	Blue.
Cuprammonium..	Dissolves; does not deposit on standing.	Dissolves; throws down heavy precipitate on standing.	Does not perfectly dissolve; throws down moderate blue sediment.

Besides the reactions noted in the table, levan is not precipitated by acid mercuric nitrate, by ferric chloride, by copper sulphate, or by tannic acid.

The barium compound prepared by freeing the gum from phosphoric acid by dialysis, treating with excess of baryta water, quickly filtering,

* Under particular conditions a precipitate is produced when a strong solution of levan is mixed with lime water, but this is extremely soluble and dissolves readily in a small excess of either solution.

† Several samples of inulin prepared directly from dahlia tubes grown at Sydney gave a precipitate with strontia water, whilst a European commercial sample gave none The Sydney preparations gave the normal $[\alpha]_D$ reading.

washing with alcohol, and drying first in vacuo over sulphuric acid, and then in a current of air free from carbon dioxide at 100° C., under 100 mm. pressure, contained 19·85 per cent. of BaO, a percentage similar to that found by Asboth for starch (Analyst, 1887, 12, 138).

On heating the dry and powered gum in capillary tubes, it showed signs of melting at 183° C., at 193° C. the fragments became soft and adherent, and begin to rise in the narrow tube, at 198° steam bubbles were well marked, and at 200° the gum melted to a transparent frothy mass.

The nearest allies to levan appear to be inulin and levulan, but as has been shown, it differs in important respects from these. It also certainly differs from the described derivatives of inulin, *viz.*, pyro-inulin, metinulin, and levulin, as well as from the bodies which have been described as sinistrin, triticin, secalose, and myco-inulin.

The figures following show the effect of the growth of the bacillus in a solution of saccharose of 10 per cent. strength, as described at beginning of this paper. After removal of the gum by precipitation with alcohol (the acidity being first neutralised with sodium hydroxide), and concentration of the saccharine solution, the residual syrup was found to contain for each 100 parts of saccharose originally present: saccharose, 5·4; dextrose, 41·4; levulose, 20·6. It is thus seen that during its growth, the bacillus has inverted the saccharose and assimilated levulose. The difference between the dextrose and levulose in the residual syrup represents the levulose which has been used by the bacillus, and amounts to 20·8 per 100 of original saccharose. Were there as much levulose present as dextrose, the sum of the two sugars would be 82·8, which is equivalent to 78·7 of saccharose. This proportion, with the 5·4 still present, leaves 15·9 of saccharose not accounted for. A little of this may be due to mechanical loss during manipulation; and the remainder, which may be stated as at the very least 10 per cent., represents saccharose used up by the bacillus in addition to the missing 20·8 of levulose. These results were checked by examination of several different cultures, and in each case figures of a similar nature was obtained.

In a culture made in 20 per cent. solution of saccharose, the growth of the bacillus was not nearly so abundant as in those made in 10 per cent. solutions, and the transformation of saccharose was correspondingly less complete.

The nature of the acids secreted during the growth of the bacillus is of interest, even though the total amount of these be relatively small. Carbonic acid was evolved in the proportion of about 1·28 grms. for each litre of cultural fluid containing 10 per cent. of saccharose. Of the acids remaining in the fluid, the most abundant was lactic, which was responsible for the greater part of the acidity. Besides these there were present smaller amounts of capric, butyric, acetic, and formic acids.

In the mucinous fermentation of beet juice by some bacteria, as, for example, *Leuconostoc mesenterioides*, the sugar is changed partly to dextran (also called fermentation gum), of which there are two modifications, one soluble, the other insoluble in water, and partly to the hexatomic alcohol mannite. Another gum-producing organism, *Bac. gummosis*, Happ, also forms mannite when grown in sugar solutions. A careful examination of the cultural fluid from the growth of *Bac. Levaniformans* was made, but no trace of mannite could be detected. Ordinary alcohol also was not amongst the products of the fermentation.

So far, we have been considering the action of a bacillus which was separated from cane juice. In the examination, however, of a number of raw and refined sugars, many races of the same organism were isolated. By the cultivation of these on various media, such as agar, gelatine, potato, bouillon, and milk, well-marked differences in habit were brought out. These races could be divided into one, two, or three groups, according to the value placed upon their growth characteristics. By repeated cultivation, the characters of one group alter and become identical with those of another, until reversion to the normal type is complete. The change to the normal type occurs in the course of a few crops or transfers in the case of some of the races, whilst with others reversion was much slower.

The existence of these different races can perhaps be best accounted for by the varying physical conditions that have obtained during the process of manufacturing the sugar. These would be quite sufficient to cause the change from one race to another. The cultural variation of the race has but little if any effect upon the production of levan, the yield of this substance apparently depending on the nature of the medium in which the organism is grown.

The normal type of *Bac. Levaniformans* may be described as a rod with rounded ends, the individuals occurring singly and in chains. The dimensions vary considerably, the cells usually measuring 0·4—0·6 by 2—3 μ. Some of the derived races consist of a mixture of short stout, and of long rods, varying from 1·3 by 2·0 to 1·0 by 6 μ. Germination is lateral. The rods are motile, and in bouillon move about with a wriggling motion. In films of fluid saccharose media, the newly germinated rods have an active darting motion. There is practically no growth under anaërobic conditions.

The rod forms a small oval and generally central endospore. The spores, like those of other bacilli, are capable of withstanding a moist heat of 100° C. for some time. Several tubes of saccharose media were infected with spores, and, after attaching aerial condensers, the tubes were immersed in brine which was kept slowly boiling. The media in the tubes boiled briskly. At various intervals up to five hours, tubes were taken out, cooled, and thereafter incubated at

37° C. In all cases growth occurred and gum was formed. The spores can, therefore, withstand the action of boiling water for at least five hours, thereby proving as tolerant of heat as the potato bacillus of Lafar, the most powerfully resistant organism hitherto known.

It is a matter of common observation that considerable alteration may take place in the composition of raw sugars either whilst awaiting shipment from the sugar mills, during transport, or whilst lying in store at the refineries. The most prominent sign of this change is an increase in the amount of reducing sugars. This alteration means of course a corresponding depreciation in the value of the sugar, and the monetary losses caused thereby have at times been very heavy.

An examination of numerous samples of raw and refined sugars from various parts of the world, has shown *Bac. Levaniformans* to be very widely, if not universally distributed, and its presence was not confined to sugars derived from the sugar cane, for we found it in both raw and refined beetroot sugars. Whether the bacillus exists in small or large numbers in any given sample is of little significance; the mere fact of its being present is sufficient, as, under favourable conditions, multiplication is very rapid.

Although present in so many different samples, the organism is not in an active or growing state in all. When the conditions (moisture, temperature, &c.) are unfavourable, growth will be in abeyance, and in such cases the sugar will remain unchanged. In all samples of sugar examined by us in which spontaneous inversion was known to be proceeding, the bacillus was found in an active state, and, in some cases, in practically pure culture.

It has been already noted that, in experimental cultures, an increase of peptone gave an increase of gum levan and a relative decrease of hexoses (reducing sugars), and conversely, with decreasing amounts of nitrogenous material, there was a decrease of gum and a relative increase of reducing sugars. We have further shown that the bacillus is capable of growing in solutions of cane sugar containing but a trace of nitrogenous food, as, for example, in solutions containing one-thousandth of a per cent. of peptone.

The amount of nitrogenous matter existing in refined sugar crystals is infinitesimal, whilst that in raw sugar is also but small, and it is probable that when the bacillus is growing in such sugars the gum-forming faculty may be in abeyance. Examination of sugar samples in which a vigorous growth, accompanied by heavy inversion, had taken place, showed the complete absence of gum.

An interesting instance is furnished by a sample of raw sugar which had been damaged by water and so rendered particularly suitable for the growth of the bacillus. In November, 1895, when the observation commenced, this sample contained close on 7 per cent. of water and

0·90 per cent. of reducing sugar. The sample was kept in a stoppered bottle, which was only partially filled, and the reducing sugar determined from time to time. The amount of reducing sugar rose steadily, until, in November, 1901, it amounted to 32·7 per cent., of which 18·9 was dextros and 13·8 levulose. The bacteriological examination showed that the sugar contained *Bac. levaniformans* in practically pure culture, there being present one inert bacterium to every ninety-nine active bacilli. A careful chemical examination was made, but no levan could be detected. It is quite probable that the physical condition of the sugar, as regards moisture, temperature, &c., may have an influence on the bacillus of the same kind as is produced by nitrogen starvation. Further, the hydrolytic action of the acid products of the fermentation will also tend towards the disappearance of any gum which may be formed.

The facts which we have recorded above render it highly probable that this organism is responsible for the bulk of the deterioration of sugar during transit and in store, which has been noted from various parts of the world, and has from time to time been the cause of heavy loss to sugar manufacturers and refiners. A certain degree of moisture and warmth appear to be the predisposing causes for the growth of the bacillus, whilst experience has shown that absence of moisture is the surest safeguard in the other direction.

(To be continued.)

CONSULAR REPORTS.

Austria-Hungary.

Value of exports of sugar during the years 1901-02:—

Destination.	1901. £	1902. £
All Countries	7,361,206	5,541,490

Of this the quantities and values of the sugar sent to the United Kingdom and India were as follows:—

	Quantity. 1901. Cwts.	Quantity. 1902. Cwts.	Value. 1901. £	Value. 1902. £
United Kingdom—				
Refined (no bounty) .	14	18	10	11
Second class (bounty 3·20 kr.)	775,901	740,392	330,468	252,697
Third class (bounty 4·30 kr.)	5,451,498	4,741,695	2,884,298	1,993,354
British India	2,623,608	2,047,969	1,385,925	858,259

Bohemia.—The unusually large stocks carried over from the previous year, as well as a greater production, caused prices for sugar to fall to an unprecedented figure during the campaign of 1901-02, which would have been still more marked had not the beet sugar producing countries diminished the area under beet cultivation by about 10 per

cent. When prices fell to 18s. per 220 lbs. in Bohemia in July it was thought that the lowest point had been touched, but in September there was a still further decline at Aussig on the frontier to 13s. 4d. per met. centner (220 lbs.); later, prices recovered, and on December 26 the highest point was reached at 18s. 2d. per 220 lbs. from Aussig.

The law authorising the contingent system, passed by the Austrian Parliament, was brought forward by the Government with the avowed object of protecting smaller and less favourably situated mills and preventing them being swamped by the larger, in which case agriculturists would also suffer. The system proposed was, practically speaking, a Trust in favour of sugar producers, refiners, and growers of beet. The Brussels Sugar Commission recently found that this law was not in keeping with the spirit of the Convention, and it has been abandoned.

In consequence of the abandonment of the sugar bounty there is no doubt that assistance will be given to this industry by considerably reducing railway rates, not only to frontier stations and export ports, but also on the conveyance of raw sugar from the mills to the refineries, and on the carriage of beetroot, coal, &c.

The association of raw sugar manufacturers came to an arrangement whereby growers of beet were compelled to deliver their beet at fixed prices to the different sugar mills in their particular "rayon" or district; the unfairness of this system caused the farmers to petition the Government, and a law is about to be passed forbidding it.

In the 1901-02 campaign there were, in Bohemia, 128 mills using 4,000,000 tons of beet, which produced 658,285 tons of raw sugar out of a total production in Austria, Hungary, and Bosnia of 1,291,127 tons.

Germany.

The Consul-General reports:—On September 1st, 1903, the Brussels Sugar Convention comes into force, when all export premiums and bounties will cease in the Treaty States. In order to regulate the production and export of sugar from the Treaty States a meeting of delegates of the sugar producers of these countries was convened at Brussels on July 6th, 1903, when resolutions were passed to the effect that the entire production and the quantity destined for exportation should be distributed according to a fixed plan among the respective countries. It is expected that this arrangement will be ratified by the producers.

The preserved fruit industry, which was hitherto handicapped by the high sugar prices in Germany, will, it is anticipated, derive great benefit from the Convention. The reduction of the internal consumption tax from £1 to 14s. is apparently deemed sufficient to render the manufacture of preserves and jams profitable.

From September 1st duty on sugar imported into Germany from countries included in the Brussels Convention and on sugar exported from and re-imported into Germany will be levied at the rate of 18 marks 80 pf. (18s. 7½d.) per 100 kilos. of refined sugar and its equivalents, and at the rate of 18 marks 40 pf. (18s. 4d.) per 100 kilos. of raw sugar.

The prospects of the beetroot harvest are good, the weather having so far been favourable to the growth and quality of the beets.

In 1901 and 1902 the sugar factory at Dingelbe, near Hildesheim, in the province of Hanover, experimenting with one of Messrs. Petry and Hecking's drum apparatus, obtained a yield of 1 cwt. dried chips from 4½ cwts. raw chips. The former was sold at 5s., and as the cost of the drying process was 1s. 5d., the cwt. of beetroots realised nearly 9½d. If the cwt. of dried chips is sold at 6s., the cwt. of beetroot yields a little more than 1s. Their nutritive qualities render the dried chips an excellent substitute for maize.

Dantzig.—Over-production during the year 1901, and the bounties and cartels had a depressing effect on the beetroot sugar trade during the year 1902. The future prospects of the industry are, however, considered to have been improved by the signing of the Brussels Convention doing away with bounties from September 1st, 1903. 221,730 tons of beetroot sugar were shipped in 1902, of which 110,849 tons went to the United Kingdom. The figures for 1901 were: Total shipments, 159,281 tons; to the United Kingdom, 98,719 tons. The large sugar refinery at Neufahrwasser, near Dantzig, which was burnt down two years ago, has not as yet been rebuilt, the directors wishing first to see how the trade in refined sugar is affected by the Brussels Sugar Conference before going to the expense of restarting their works.

South Italy.

The increased production of beetroot sugar and the considerably larger area consequently laid under this crop in South Italy is a comforting element in agricultural matters, and it seems possible that in the near future the country may produce all the sugar it requires, and cease any further importations. In fact, the existing refineries could nearly supply the country if worked to the full extent of which they are capable, so that, unless the consumption increases, it is by no means impossible that there may be a sugar crisis to add to the number of agricultural difficulties which beset Italy. There is some talk of forming a large and comprehensive Italian Sugar Trust, which would not meet the case nearly as well as to increase the consumption by the sure method of lowering the price.

The following table in 1,000 quintals (10 tons) of sugar shows the continuous progress of the last six financial years. The imports are calculated by solar years from the close of 1895:—

Year.	Number of Refineries.	Sugar in 1,000 Quinsals. Produced.	Imported.
1895-96	2	26·5	..
1896-97	2	23·0	740·3
1897-98	4	38·8	755·8
1898-99	4	59·7	719·3
1899-1900	13	231·1	614·7
1900-01	28	601·2	522·6
1901-02	33	713·0	371·9

The import statistics of 1902 are not yet to hand, but it is not considered likely to reach more than 220,000 quintals, or nearly 152,000 quintals less than 1901. Nor have we yet the statistics of the home sugar crop of 1902, as the financial year closes before it is gathered. It is fair, however, to argue that in the view of the diminished importation the home crop will reach about 1,000,000 quintals. Adding these together we find that for 1902 we shall have a total of 1,220,000 quintals, which will show an increased consumption per head of population of something over half a kilo. (say $1\frac{1}{4}$ lbs.). This is so far a satisfactory increase, and taking the amount produced in 1902, we may consider that a superficial area of about 30,000 hectares (74,000 acres) would be required to grow enough roots to account for the quantity. This land was formerly used for the cultivation of hemp and maize in about equal proportion.

To turn to the question of refineries, the following table shows a remarkable increase in these establishments:—

District.	Number. 1898-99.	1901-02.
Piedmont	1	2
Lombardy	..	2
Venetia	1	8
Emilia	..	13
Tuscan Marches	2	6
Latium	.	2
Total	4	33

The State received in taxes on the product 50,000,000 lire (£2,000,000), besides some 10,000,000 lire (£400,000) in the shape of custom dues on imported sugar.

Another item to be considered is the great increase the industry brings to the home railways, as the transport of the roots from the farms to the refineries forms a heavy item in the profits of the companies.

The cultivation of the root has vastly increased in this Consular district, and notably in the Terra di Lavoro. All the crop from this region goes to the refinery at Segni, and there can be little doubt that, in order to avoid the cost of transport, a refinery will be established in the district. This would naturally largely increase the

production, as the land is some of the best in Europe for the purpose, the soil being rich and of great depth, with an abundant water supply.

One drawback may seriously affect the growth of beetroot on the best lands, and that is the duration of the crop, for the root if sown in March cannot be gathered till October, whereas if hemp be grown on the same quality of land the crop is cut by the middle of July, leaving time to grow a crop of maize on the same ground. Unless the beet proves exceptionally remunerative, the land would not yield as much money under it as it would with hemp and maize. Nor could a green crop be grown after beet for winter cattle food and subsequent ploughing in, because such a crop must be sown by the middle of September, when the beet is not yet gathered.

China.

Amoy.—Of sugar the total export during 1902 was 118,538 cwts., valued at £65,240, against 159,830 cwts., value £85,220, in the previous year.

Wuhu.—An item which calls for special notice is sugar, the total of 188,370 cwts. being the highest on record. White refined sugar especially seems to have found favour in the neighbouring markets, the import this year having risen by about 33 per cent. as compared with 1901. Sales of sugar have improved considerably of late, thanks to a system of Chinese agencies which have been established at various places in the interior in connection with a British firm, for the special purpose of selling foreign sugar wholesale. Some opposition was made at first by likin officials, but it has been, so far, successfully overcome in most cases.

The decline in the import of native sugar continues, the total amount imported in 1902 being 75,224 cwts., as against 107,213 cwts. in 1901.

Correspondence.

GERMAN SUGAR CARTEL.*

To the Editor of "The International Sugar Journal."

Sir,—The German raw sugar manufacturers are trying to arrange some cartel by which raw sugar may be sold to German refiners at the world's market price, plus a fixed amount of 2·40 Ms. per 50 kilos. of raw sugars. This means that German refiners and German sugar consumers must pay, by order of the new German Cartel, the full amount of the surtax accorded by the Brussels Convention. This arrangement is contrary to the meaning and against the intention of the Brussels Convention. This latter

* This letter was accidentally omitted from our last issue.—(*Ed. I. S. J.*)

international agreement purposes to establish free trade in sugar in the different countries, and if German raw sugar manufacturers start a central selling bureau in Berlin, keeping all the raw sugar in one hand, the free trade principle will be broken, and the stipulations of the Brussels Convention will not be carried out. The Convention stipulates that the surtax shall be the span within which the free competition of sugar may be carried out.

I consider this intended new sugar Cartel of the German raw sugar manufacturers no better—and no worse—than the Austrian allotment system, which was condemned by the International Commission in Brussels, and which was repealed by the Austrian Government.

These lines may therefore warn German manufacturers to carefully consider before they get into trouble with the International Commission in Brussels. As I predicted in March last, the Austrian allotment system has fallen, and I am sorry to say I am now in the same position to-day in regard to the new German raw sugar Cartel.

I am, Sir,

Yours Sincerely,

SIGMUND STEIN.

214, Upper Parliament Street,
Liverpool, 24th August, 1903.

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. THOMPSON, C.E., F.C.S., M.I.M.E., Chartered Patent Agent, 6, Lord Street, Liverpool ; and 322, High Holborn, London.

ENGLISH.—APPLICATIONS.

17893. H. HEBBINGHAUS, London. *A new or improved device for the removal of moisture from confectionery and other materials or articles stored in vessels.* Complete specification. 18th August, 1903.

18044. J. KRIVANEK, London. *Improvements in and relating to the manufacture of sugar.* Complete specification. 20th August, 1903.

ABRIDGMENTS.

23779. J. McGLASHAN, Cawnpore, India. *Improvements in the manufacture of sugar.* 31st October, 1902. This invention has for its object an improved process for removing invert sugar from sugar solutions, cane juices, or molasses, so as thereby to raise the standard

of purity of the liquors treated, and increase the yield and improve the quality of the sugar crystals obtained.

It consists in "pitching" the juice, or the liquor contained therefrom, with an organism or organisms of non-inverting or slighting inverting yeast—like types, such as of the saccharomycetes, schizo—saccharomycetes, saccharomyces, apiculatus, and torula types, at any of the following stages in the process of manufacture:—(*a*) at the juice stage after the crushing or diffusion processes and before defecation; (*b*) after defecation; (*c*) after concentration of the liquor to the density below that at which it will deposit crystals when allowed to cool; (*d*) after evaporating in multiple effect apparatus and before the final vacuum process, fermenting the juice or liquor, as the case may be, and distilling off the alcohol produced.

26716. Mr. J. W. MACFARLANE, of the firm of Watson, Laidlaw, and Co., Glasgow, N.B. *Improvements in centrifugal machines.* 4th December, 1902. This invention has for its object to improve the construction and action of centrifugal machines so as to obtain a better classification or separation of the syrups, liquors, and washings which are discharged from the centrifugal machine during the operations of purging, liquoring, washing, or steaming of sugar and similar granular substances. It consists in providing a basket, having a solid shell, perforated lining supported in the basket so as to leave an annular space between such linings and the shell; a circular chamber communicating with this annular space, a discharge opening leading from such space, an injector mechanism connected with the circular chamber, in combination with collecting gutters, and a movable screen for conducting the effluent into one or other of the gutters.

5829. J. MCNEIL, Govan, Lanark, N.B. *Improvements in and connected with sugar cane mills.* 13th March, 1903. In sugar cane mills, in which two preparatory splitting rollers are combined with the usual mill rollers, a gearing shaft is provided coupled to one of the lower splitting roller shafts, a spur wheel on the gearing shaft gearing with a second spur wheel on a second motion shaft or on an intermediate shaft of the usual gearing of the mill.

7998. S. STEIN and C. J. CROSFIELD, J.P., Liverpool. *Improvements in or connected with the manufacture and refining of beet, cane, and other sugars.* 7th April, 1903. This improvement connected with the refinement of beet, cane, and other sugars, consists in treating raw sugar juices, which have been first treated with carbonic acid, or are in an acid state, with peroxide of barium, by which the whole mixture is brought to an acid state.

GERMAN—ABRIDGMENTS.

142449. A. W. MACKENSEN, G. m. b. H., of Schöningen. *Shreddings press with centrically mounted conical press spindle and means for a preliminary pressing of the shreddings.* 23rd August, 1902. Tapering shoulders or projections are provided on the press spindle or the straining cylinder surrounding the press spindle, so that the pressing chamber is considerably narrowed by these shoulders projecting into it.

142241. JAN STUDZINSKI, of Wolyn, Russia. *Means for closing centrifugals for casing sugar by means of steam.* 9th September, 1902. In order to prevent the escape of steam used as casing medium from the main discharge pipe—this pipe is formed as a waterseal. The centrifugal is also provided with a separate steam escape pipe branching off the upper part of the syrup discharge pipe.

142275. GEVERS FRÈRES, Antwerp. *Casing centrifugal for making sugar tablets in removable moulding boxes.* 3rd July, 1901. The moulding boxes, which are open in front and behind, are made in two parts. Each part has two sides of the box. Both parts are fitted together at diagonally opposite corners by means of clasps adapted to be inserted in suitable grooves in the walls of the box. The front edge of the box is also bevelled, and this bevelled edge of the box fits against an edge formed by ribs or intermediate pieces in the interior of the centrifugal.

142890. SELWIG and LANGE, of Brunswick, Germany. *A stone catcher for beet root shredding machines and the like having a horizontal slicing disc.* 29th August, 1902. A case forming the stone catcher is arranged over the horizontal slicing disc. Stones and pieces of beet root pass into the stone catcher through a slot. When the stone catcher is completely filled its contents are pushed along the inclined or curved rear wall of the stone catcher and then pass slowly out of an aperture leading to the outside.

IMPORTS AND EXPORTS OF SUGAR (UNITED KINGDOM,)

To end of August, 1902 and 1903.

IMPORTS.

Raw Sugars.	Quantities.		Values.	
	1902.	1903.	1902.	1903.
	Cwts.	Cwts.	£	£
Germany	4,404,014	3,018,051	1,523,856	1,245,633
Holland	244,206	162,407	78,074	61,980
Belgium	423,180	619,912	152,500	258,269
France	1,544,316	476,985	602,360	209,457
Austria-Hungary	66,410	1,483,228	22,580	621,907
Java	....	211,900	....	100,472
Philippine Islands	....	70,646	....	25,285
Peru	91,405	199,549	31,114	78,780
Brazil	516,405	67,076	170,614	26,185
Argentine Republic	537,582	409,947	197,821	184,810
Mauritius	263,975	264,040	92,566	94,226
British East Indies	154,388	158,235	56,117	57,874
Br. W. Indies, Guiana, &c.	1,181,256	522,807	689,416	319,731
Other Countries	122,657	913,802	47,749	418,103
Total Raw Sugars	9,549,794	8,578,585	3,664,767	3,702,712
Refined Sugars.				
Germany	9,668,723	10,730,678	5,069,451	5,583,838
Holland	1,649,315	1,533,069	951,717	884,641
Belgium	115,694	95,163	67,109	55,745
France	2,016,521	611,498	1,047,418	347,418
Other Countries	11,329	830,320	5,674	409,477
Total Refined Sugars	13,461,582	13,800,728	7,141,369	7,281,119
Molasses	923,202	1,023,010	174,792	186,736
Total Imports	23,934,578	23,402,323	10,980,928	11,170,567

EXPORTS.

British Refined Sugars.	Cwts.	Cwts.	£	£
Sweden and Norway	26,094	17,327	14,684	8,976
Denmark	91,303	67,789	46,857	36,856
Holland	43,802	42,324	22,863	22,865
Belgium	6,262	5,205	3,240	2,618
Portugal, Azores, &c.	6,365	5,611	3,228	3,064
Italy	16,404	6,622	7,752	3,028
Other Countries	221,500	483,341	134,567	292,548
	411,730	628,219	233,191	369,955
Foreign & Colonial Sugars.				
Refined and Candy	35,506	31,884	22,066	19,267
Unrefined	57,891	42,663	29,606	22,184
Molasses	1,293	1,270	526	669
Total Exports	506,420	704,036	285,389	412,075

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1903. Tons.		1902. Tons.
Total Receipts, 1st Jan. to Sept. 17th ..	1,281,911	..	1,255,448
Receipts of Refined ,, ,, ,, ..	1,197	..	14,967
Deliveries ,, ,, ,, ..	1,233,744	..	1,262,165
Consumption (4 Ports, Exports deducted) since 1st January	1,226,108	..	1,216,990
Importers' Stocks (4 Ports) Sept. 16th ..	50,552	..	18,594
Total Stocks, September 23rd	177,000	..	169,581
Stocks in Cuba ,, ,, ...	171,000	..	144,268
	1902.		1901.
Total Consumption for twelve months ..	2,566,108	..	2,372,316

CUBA.

STATEMENT OF EXPORTS AND STOCKS OF SUGAR, 1902 AND 1903.

(Tons of 2,240lbs.)	1902. Tons.		1903. Tons.
Exports	614,815	..	772,281
Stocks	199,536	..	203,683
	814,351	..	975,964
Local Consumption (eight months)	25,740	..	26,045
	840,091		1,002,009
Stock on 1st January (old crop)	19,873	..	42,530
Receipts at Ports up to 31st August ..	820,218	..	959,479

J. GUMA.—F. MEJER.

Havana, 31st August, 1903.

UNITED KINGDOM.

STATEMENT OF IMPORTS, EXPORTS, AND CONSUMPTION FOR EIGHT MONTHS ENDING AUGUST 31ST.

SUGAR.	Imports. 1903. Tons.	Imports. 1902. Tons.	Imports. 1901. Tons.	Exports (Foreign). 1903. Tons.	Exports (Foreign). 1902. Tons.	Exports (Foreign). 1901. Tons.
Refined	691,543	672,272	697,248	1,593	1,775	3,117
Raw	430,223	478,983	457,418	2,132	2,894	4,481
Molasses	51,243	45,654	63,522	63	64	2,469
Total	1,173,009	1,196,909	1,218,188	3,788	4,733	10,067

HOME CONSUMPTION.

	1903. Tons.		1902. Tons.		1901 Tons.
Refined	634,024	....	669,095	....	—
Raw	387,679	....	447,108	....	—
Molasses	41,281	....	42,691	....	—
Total	1,062,984	....	1,158,894	....	—
Less Exports of British Refined	31,410	....	20,586	....	—
Net Home Consumption of Sugar	1,031,574	....	1,138,308	....	1,130,906*

* Trade estimate.

STOCKS OF SUGAR IN EUROPE AT UNEVEN DATES, SEPT. 1ST TO 23RD, COMPARED WITH PREVIOUS YEARS.

IN THOUSANDS OF TONS, TO THE NEAREST THOUSAND.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	TOTAL 1903.
138	542	565	70	127	1443

	1902.	1901.	1900.	1899.
Totals	1403 ..	570 ..	410 ..	571

TWELVE MONTHS' CONSUMPTION OF SUGAR IN EUROPE FOR THREE YEARS, ENDING AUGUST 31ST, IN THOUSANDS OF TONS.

(From Licht's Monthly Circular.)

Great Britain.	Germany	France.	Austria.	Holland, Belgium, &c.	Total 1902-03.	Total 1901-02.	Total. 1900-01.
1711	831	547	382	500	3971	4109	4168

ESTIMATED CROP OF BEETROOT SUGAR ON THE CONTINENT OF EUROPE FOR THE CURRENT CAMPAIGN, COMPARED WITH THE ACTUAL CROP OF THE THREE PREVIOUS CAMPAIGNS.

(From Licht's Monthly Circular.)

	1902-1903. Tons.	1901-1902. Tons.	1900-1901. Tons.	1899-1900. Tons.
Germany	1,748,555 ..	2,304,924 ..	1,984,186 ..	1,798,631
Austria	1,057,202 ..	1,302,038 ..	1,094,043 ..	1,108,007
France	873,178 ..	1,183,420 ..	1,170,332 ..	977,850
Russia	1,220,000 ..	1,098,983 ..	918,838 ..	905,737
Belgium	215,000 ..	334,960 ..	393,119 ..	302,865
Holland	102,411 ..	203,172 ..	178,081 ..	171,029
Other Countries.	350,000 ..	393,236 ..	367,919 ..	253,929
	5,566,346	6,820,733	6,046,518	5,518,048

THE

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All Advertisements to be sent *direct*.

Cheques and Postal Orders to be made payable to Norman Rodger, Altrincham.

☞ The Editor is not responsible for statements or opinions contained in articles which are signed, or the source of which is named.

Blyth Bros., Mauritius, report shipments of sugar from August 1st to 16th September at 17,361 tons, as compared with 11,061 tons in the corresponding period of 1902-03. All of it went to British India.

The Position of Demerara Sugar.

It is surprising to find how widespread is the fallacy involved in the statement that the West Indies and British Guiana will now lose the advantages they previously enjoyed in the American market over European bounty-fed sugar owing to the latter being subjected to a countervailing duty. We should have thought that the facts pointed rather the other way. The *status quo* of the period prior to the 1st September was as follows: The beet sugar enjoyed a bounty, the West Indian did not; the former was thereupon neutralized by a countervailing duty on entry into the United States; the net result was therefore one of equality. Once the bounties cease, the need to countervail them ceases too; the net result is again the same. So much for the direct bounties. Now according to a statement in the *Demerara Chronicle*, there is a suspicion that Germany will continue to gain an advantage owing to her exporters possessing a surtax of mks. 4·80 with which to manipulate the prices. This is admitted to be an indirect bounty and, so it is said, an agitation has been started in the United States to get the Government to countervail it. It may or may not be an indirect bounty, and the United States of America may have a moral right to countervail it, providing they refrain from becoming a party to the Brussels Convention. But what one would

like to ask is this: Why do these agitators only now raise a cry against this surtax? Why did they not take action when it was fixed at mks. 20? Cannot these individuals see that what affected West Indian sugar most previous to the abolition of bounties was not the direct bounties, which were neutralised, but the cartel bounties (on a 20 mks. scale) which were not touched by any countervailing duty. The United States had evidently good reasons of their own for not tampering with them, the principal one being doubtless that they had a few cartels of their own in process of formation, only they called them by another name. Taking these facts into consideration, we fail to see that the West Indies are now any worse off; we do think, on the contrary, that their prospects have improved by a long way. They have gained a large and increasing market in Canada, they are able to enter their sugar into the United Kingdom on practically equal terms with Continental exporters, and finally the oppressive influence of a cartel bounty has been cut down from 20 mks. to 4·80 mks. at least. This last advantage really improves the position of West Indian sugar in the United States market. Of course the Cuban Reciprocity Treaty, should it ever come into existence, would exercise an adverse influence—but "that is another story."

The Sugar Tax.

Mr. Chamberlain's plans have now been made public, and there is no doubt that his endeavours to secure closer relations between the Colonies and the Mother Country form a step in the right direction. Whether the country is yet ripe for a change or not is a matter of opinion, but there is no doubt that he has met with a better reception and secured more sympathizers for his propaganda than was anticipated a few months ago. His proposals include the reduction of the sugar tax by 50%. Instead of welcoming this fact, the "cheap sugar" fraternity see in it merely a device to make the taxing of sugar a permanent source of revenue, and, to use their own words, they propose to organize a "raging, tearing propaganda" in opposition. We were under the impression that it had been distinctly affirmed that the introduction of a tax on sugar, while rendered the more urgent owing to the war expenditure, was not a war tax, but one devised to broaden the basis of taxation. Its ultimate retention or otherwise was therefore dependent on the ideas prevailing in Parliament as to the fiscal system under which it was arranged, and not on the existence or termination of a war.

Certainly the taxation of food (whether it be sugar or tea, coffee, corn, etc.) is to be deprecated from some points of view, but once its indirect influence on the prosperity of the nation can be shown, it must be justified as a necessary evil. Undoubtedly it could be arranged so as to increase our trade with our Colonies, and, as regards sugar, within five years we shall be at liberty to give preferential rates

to colonial sugar. A small duty on foreign sugar and none on colonial would then be feasible and would be preferable to the present high duty on all sugar irrespective of origin.

Inaccuracy of Brix Hydrometers.

An American sugar chemist writing to the *Beet Sugar Gazette* alleges that the majority of Brix spindles are inaccurately graduated. He had occasion a short while back to return one to the makers which was more than usually inaccurate, and was thereupon told that his was the first complaint made. If that was so, it was hardly to the credit of the average sugar chemist. As the object of a Brix reading is to determine the apparent purity of a sugar solution, it is clear that any error in the Brix will make a large error in the apparent purity. The complainant goes on to state his own *modus operandi*. "My method of getting at the correct Brix has been to test all spindles when received at the top, middle, and bottom parts of the scale with pure sugar solutions at the normal temperature, and to make the necessary correction in the reading along with the temperature correction every time a spindle is used. The necessity for this correction complicates the laboratory work, and requires extra assistants where there is much work to be done. And I believe it could be avoided if sugar chemists would test their spindles by this very simple and accurate method and report inaccuracies to the makers. At the prices charged for standard hydrometers they should be correct, and, I think, would be made so if sugar chemists refused to accept them when not correct." M. Sachs, of Brussels, has spent a good deal of time in investigating the matter of scales and graduations on measuring instruments; he read a paper on the subject at the Berlin Congress in June last, and in our issue of November, 1902, appeared a translation of an article from his pen on "A few Figures for the Checking of Chemical Apparatus."

Coolie Labour in South Africa.

The paper, "Sugar making in Natal," which appears in our present issue is from the pen of a newspaper correspondent, who accompanied Mr. Chamberlain in his recent tour in South Africa. Much of it will be very elementary to our readers, but the discussion of the Indian coolie system is of considerable interest just now in more than one sugar country, so that this additional contribution to the subject, favourable as it is to the system, is worth placing on record. It would certainly be an unfortunate day for South Africa if the restrictions to native labour recently enforced in Australia were similarly introduced there at the dictation of trades' unions and labour associations. It is patent that the conditions of climate render cheap white labour an impossibility, and while there may be good reasons

for objecting to Chinese immigration, these objections do not apply to our Indian subjects. Removed from the centre of caste prejudice and superstition, these Indian coolies are more likely to develop into reliable and loyal citizens of the Empire than if left in their native country to be despised and downtrodden by persons of superior caste. In this connection it is interesting to note that one of Mr. Chamberlain's last acts at the Colonial Office was to refuse to countenance the attempt which is being made to stop coolie immigration in British Guiana. He doubtless considers that such a policy, if carried out, would be disastrous, particularly at this juncture, when that Colony is about to gain a fair footing in the sugar market of the world.

Cuba.

A correspondent writing to the *Louisiana Planter* avers that the equipment of the sugar factories in Cuba is totally behind the times and would have to be wholly renewed in order to bring it up-to-date. According to him, processes involving thorough imbibition of the bagasse, rational evaporation, and saving in steam, do not exist on any of the Cuban factories. The total ignorance of the Cuban planter with regard to chemical matters, leaves him a prey to American machinery manufacturers who take advantage of his fondness for anything new to deceive him, pretending that the apparatus they offer is better than those he has heretofore ordered from Europe.

Most of the plantations have double crushing, but the extraction is said to be rather small, not exceeding 70 or 72 per cent. on the weight of cane even with a cane shredder.

As the factories can generally obtain cheap as much cane as they need, they are not very careful about the extraction; hence with a cane having a saccharine richness of 13 to 15 per cent. from December to May last, an extraction was obtained of only 9 to $10\frac{1}{2}$ % sugar of 95 test. French machinery is said to predominate on most of the older Cuban plantations, but if the reciprocity treaty comes into force, American machinery will speedily supersede it.

The above accounts of Cuba are scarcely what one expected to hear: it was generally supposed that her equipment was the best in tropical America, and that she could already in a few cases turn out sugar at $1\frac{1}{4}$ cents a lb. Now we are told that, failing reciprocity, this latter figure will be imperative everywhere if her factories are to compete successfully. No mention is made of the part played by the not inconsiderable amount of British sugar machinery in use in the island. This is certainly not out of date.

Almost the entire Demerara sugar crop has this year gone to Canada instead of the United States. The preferential tariff is no doubt responsible for this.

TIN IN YELLOW SUGAR.

By A. Urich, Ph.D., F.I.C.

The scare caused two years ago by the tracing of arsenic in the beer of Manchester and afterwards in the glucose used in brewing this beer, was soon followed by an alarming report amongst the sugar planters that yellow sugar made with "Bloomer" or tin salts would be objected to as containing a poisonous substance.

As with better prices the manufacture of yellow crystals is likely to revive, it might be opportune to see how much tin there is really in a pound of such sugar.

Dr. T. H. Stevenson, recently a member of the "Arsenic-in-beer-commission," states in the 4th edition of Taylor's Medical Jurisprudence (edited by him in 1894): "Demerara sugars contain about 0·5 to 0·3 grains of tin per pound. Neither dogs fed on such sugars, nor persons who habitually consume such sugar as an article of daily diet suffer in health."

This statement was made in 1894, when yellow crystals used to be made more moist than at present. As the tin compounds are confined to the thin film of molasses sticking to the sugar crystals, the dryer the sample the smaller the tin contents will be. In such a dry sample analysed by me whilst in temporary charge of the government laboratory in Trinidad, I found only $\frac{1}{10}$ of a grain of tin per pound sugar. But even if 0·3 or 0·5 grain should be more usual, Dr. Stevenson's statement will hold good. For chloride of tin when largely diluted gets oxidized so rapidly to unsoluble oxychloride, that such small quantities as found in sugar may safely be considered as perfectly harmless, the more so when it is considered that the consumption of a pound of sugar is distributed over a period of a week or so.

How quickly chloride of tin becomes oxidized and unsoluble was pointed out by Rogers and Longstaff (see *Analyst*, 1900) who state that in water containing 0·023 grammes tin (as chloride) per litre, equal to 1·5 grains per gallon, no trace of tin could be detected after half-an-hour, unless the water had been freed previously from air by boiling. Therefore, the traces of tin in sugar must not be compared with the "metallic impurities," principally lead, found in a soluble state in aerated waters. Here an amount of 0·05 grains lead per gallon is rightly considered injurious. Should, however, out of mere principle the trace of tin found in sugar be objected to, then the trade in canned food and especially in canned fruit, which are always acid, would be seriously handicapped, if not made impossible. These articles of food often contain tin in ten or even a hundred times larger quantities, and, what is more important, in a soluble state.

Thus, W. Blyth found tin in 21 samples of canned fruit in amounts varying from 1·5 to 11 grains per pound (see Pearmain & Moor's

Analysis of Food and Drugs). In the U.S. Laboratory at New York out of 109 samples of canned food examined, 97 contained tin (see Dr. Battershall's Food Adulteration).

It might not be superfluous to draw the attention of sugar chemists to the fact that the "gold test" for tin is often misleading when applied directly to the sugar. Most moist sugars, even grey and white crystals that never have come in contact with tin salts give a purple colouration with gold chloride, often entirely due to reducing substances.

Of course, it is another question as to what advantage the public derives by the use of yellow crystals in preference to sugar with its natural dull white or grey colour. This is entirely a matter of choice and cannot be answered any more satisfactorily than why butter is made yellow with saffron, or why the slightly yellowish tinge of refined lump sugar is hidden by a wash with a blue pigment.

To improve grey crystals to a tolerably white article by mere washing in the centrifugals involves a rather heavy loss, unless the centrifugals are provided with an arrangement for admitting dry steam. Whilst in the Straits Settlements I saw such machines in use and very nice white sugar they made for the Chinese market in Penang. But I remember also that the return in sugar was only 6 per cent. from the weight of the cane (double washing in milling the cane was used).

Therefore, the use of "Bloomer" to produce an attractive sugar is quite justified, the more so, since the loss in crystals attending the use of this chemical can be recovered to a great extent in the molasses sugar. A large factory in Trinidad used to recover when making grey sugar, 78 per cent. in crystals and 13·5 per cent. in molasses sugar from the indicated sucrose in the expressed juice. When making yellow sugar the return was 77 per cent. in crystals and 12·8 per cent. in molasses sugar. This *usine* has a large supply of coolers for reboiling all molasses twice for sugar, otherwise the loss in sugar extracted would have been higher.

The inversion caused by the free muriatic acid contained in "Bloomer" or Stannine is very slight, as the acid combines with the lime and other salts of the "masse-cuite," setting free the organic acids which have very little inverting power. Moreover, by using tin salts instead of Stannine the amount of muriatic acid can be reduced considerably.

It would be certainly a deplorable retrogression if strong sulphuric acid should be used once more for making yellow crystals. Many years ago (in Vol. XV. of the *Sugar Cane*) I mentioned a case where on an estate, taking the lead for yellow crystals in Demerara, the panboiler had used so much sulphuric acid in the vacuum pan, that the polarization of the masse-cuite which had been 80 per cent. before the acid was drawn in, had retrograded to 50 per cent. after the half

emptied pan had been filled up and struck. Of course this was the abuse and not the use of the acid, as the Hon. W. Russell pointed out to me at the time. All the same sulphuric acid is a highly dangerous chemical to use in the pan.

As for the use of an aniline dye for producing a "golden bloom," whether it be "Imido-tetra-methyl-diamido-phenyl-methane," or a simpler compound, such sugars would be open to the same verdict as the imitation Demerara crystals imported now and then from the beet sugar countries, viz., that they are covered with an artificial dye and "are not of the nature, substance, and quality demanded by the purchaser."

Trinidad, 7th October, 1903.

FISCAL CHANGES RESULTING FROM THE BRUSSELS CONVENTION.

NETHERLANDS.—A recent Royal Decree establishes the countervailing duties to be levied on bounty-fed sugar imported into Holland from Denmark, Japan, Roumania, Russia, and the Argentine Republic. These duties are as follows:—

	Per 100 kilogs. Florins.
Denmark—Raw sugar	0·84
Refined sugar	1·68
Japan—Candy	1·25
Roumania—Raw sugar	8·52
Refined sugar	10·80
Russia—Sugar of a richness of not less than 99%	3·90
" " " 88%	3·43
" " less than 88%	2·96
Argentine Republic—All sugar except that which is exported from that country without payment of excise duty	24·00

FRANCE.—The following is a statement of the duties now leviable in France on sugar and sugared products imported from foreign countries, together with a summary of the principal regulations affecting their importation. French colonial sugar is subject to special regulations:—

Import Duties under French "Minimum" Tariff.

Tariff No.			Frs.	Cts.
91.	Sugar, Foreign: In powder, estimated to yield on refining— 98 per cent. or less (of whatever origin)	Per 100 kilogs. net (of refined sugar)	25	00
		and, in addition, Per 100 kilogs. net (actual weight)	5	50
	More than 98 per cent.	ditto	31	00
	Refined—Candy	ditto	33	17
	Other	ditto	31	00

Tariff No.			Frs.	Cts.
92.	Molasses:—			
	For distillation, including exosmotic waters ..	Per 100 kilogs. net	0	20 Per degree of absolute saccharine richness.
	Other than for distillation, having an absolute saccharine richness of—			
	50 per cent. or less ..	ditto	19	50
	Over 50 per cent.	ditto	40	90
93.	Syrups, bonbons, candied fruits	ditto	31	00
94.	Sweet biscuits	ditto	*29	50
95.	Preserves (*confitures*):—			
	With sugar or honey..	ditto	15	50
	Without sugar or honey..	per 100 kilogs. gross	8	00
98.	Chocolate:—			
	Containing more that 55 per cent. of cocoa	per 100 kilogs. net.	†150	00
	Containing 55 per cent. or less of cocoa	ditto	101	12

The "manufacturing tax" of 1 fr. per 100 kilogs., formerly levied under the Sugar Law of 1897, is suppressed; and the "refining tax" levied under the same Law is reduced from 4 to 2 frs.

The "refining tax" is leviable at the following rates:—

		Frs.	Cts.
Refined sugar, and other sugar treated as refined	per 100 kilogs.	2	00
Sugar candy	ditto	2	14
Molasses, other than for distillation—			
50 per cent. or less	ditto	1	25
More than 50 per cent...	ditto	2	00
Syrups, bonbons, and candied fruits	ditto	2	00
Preserves (*confitures*) & sweet biscuits	ditto	1	00
Sweetened condensed milk..		0 1 or 2	80 00 00 According to proportion of sugar.
Chocolate containing 55 per cent. or less of sugar	ditto	1	13

Exhausted molasses, containing not more than 50 per cent. of actual saccharine richness, may be admitted free of duty for agricultural purposes under conditions to be fixed by Decrees.

The system of "*détaxes de distance*" established under the Law of 1897 is continued, but the amounts of the rebate (*détaxe*) are to be

* Namely, half the duty on refined sugar and on flour, with an additional 6 frs.
† Must be accompanied by certificates of origin.

calculated on the basis of the actual cost of transport; always provided, however, that the rates laid down in Articles 2 and 3 of that Law are not exceeded.

The special reductions of duty for sugar employed in sweetening wines, cider, and perry are abrogated.

The following Regulations relating to certificates of origin for sugar imported into France have recently been issued for the guidance of French Customs authorities and others:

Under the new Regulations, foreign sugar imported into any of the countries which are parties to the Brussels Sugar Convention must be accompanied by a certificate of origin setting forth—

1. The description and quantity of the sugar;
2. The description, number, and marks of the packages;
3. The countries of origin or of production;
4. The country of destination;
5. The mode of transport (railway, ship, or boat);
6. The time for which the certificate is available [maximum period—one year, not including the time during which the sugar may have remained in warehouse].

For sugar arriving from countries which are not parties to the Convention, the certificate must in addition state that they proceed from a factory not manufacturing sugar produced in a bounty-giving country to which the countervailing duty or prohibition laid down in Article 4 of the Convention applies.

These certificates must be issued by the Excise or Customs authority of the producing or manufacturing country; and, in the case of sugar from countries which are not parties to the Convention, a Consular visa may also be demanded. The certificates lose their validity if, in course of transport, the merchandise is transhipped in a bounty-giving country. Exception may be made in the case of *force majeure*, or in the case of sugar from a country which is a party to the Convention, when such sugar has passed in transit through a bounty-giving country under conditions which guarantee its identity. In such cases the Administration must be apprised of the fact.

Sugar not accompanied by a certificate of origin is subject to the highest countervailing duty fixed by the Permanent Sugar Commission, viz., 50 frs. per 100 kilogs. Exception may be made in the case of unintentional irregularities, on security being given for the eventual production of a proper certificate, or in default the payment of the maximum duty.

Proof of origin is not required in the case of importations which have no commercial character, such as parcels accompanying passengers or arriving by Parcel Post, or for domestic use; always provided that the Customs Department have no reason to suspect the origin of the products.

SWEDEN.—The ordinary duties leviable in Sweden on imported sugar are unchanged, but a surtax on sugar manufactured in Spain, Denmark, Japan, Roumania, Russia, and the Argentine Republic will be imposed at the undermentioned rates:—

Manufactured in—	Kinds of Sugar.	Surtax. Per Kilog. öre.*
Spain	Refined and unrefined	19·44
Denmark	Refined	2·52
	Unrefined	1·26
Japan	Refined sugar candy	1·88
Roumania	Refined	16·20
	Unrefined	12·78
Russia	Of a standard of at least 99% ..	5·86
	,, ,, ,, 88%	5·16
	,, ,, less than 88% ..	4·46
Argentine Republic ..	Refined and unrefined	14·85

* 100 öre = 1s. 1½d.

THE CHEMICAL NATURE OF THE PRODUCTS OF OVERHEATING OF SUGAR.

BY F. STOLLE.

(Read at the International Congress for Applied Chemistry, Berlin.)

(Continued from page 499.)

If we turn to the after-products, we must admit *a priori* that these same phenomena make an appearance to a large extent in them, but that also the heat necessitated must exercise an influence on the products of decomposition which concentrate more and more. Are these bodies really invert sugar?

In the mother syrups running from the green loaves we find them somewhat concentrated again, and we can estimate them with Fehling's solution. In that case an intense green colour is observed in the copper solution, which is not apparent when only invert sugar is concerned. This green colouring is a reduction product from decomposing bodies, which cannot be invert sugar.

In order to ascertain the nature of these green syrups, I warmed up large quantities of green syrup with Fehling's solution, and obtained on filtration a bright orange-yellow deposit which on washing changed to a dirty yellow or brown; the green colouring is consequently nothing more than a mixture of the yellow bodies and the blue Fehling's solution. Closer investigation established it as cuprous hydrate, which on washing was changed into cupric hydrate. According to Schubert, dextrine gives cuprous hydrate of a yellow colour on boiling with Fehling's solution. We can here confidently

suppose that in these green syrups there are already dextrinous bodies present, which must have formed during the refining process. The more advanced the products are, the more concentrated are these bodies, or else they undergo similar decompositions which must lead to further after-products and then are no longer recognizable by these special characteristics. This dextrine is recognized not only by its power of reduction, but also by its effect on the polarization, and by the difference between the direct polarization and that of Clerget. This appearance is according to Lippmann confined to a neutral or slightly acid reaction of the clairce and masse-cuite; with increased alkalinity the increase in rotation disappears again. Wackenroder himself establishes by numerous experiments the presence of dextrinous bodies; he even succeeded by repeatedly boiling and remelting the masse-cuite in transforming it completely into dextrine. This view of Wackenroder was also confirmed by Winkler and Degener.

But let us now return to our product. The green syrup is diluted and with an addition of lime (alkalinity 100 gr., about 1·2 c.c.m. $\frac{1}{10}$ normal acid) warmed up to 90°, filtered over fresh char, and then evaporated. The masse-cuite was next put into the malaxeurs and after 31 hours, centrifugalling commences. In order to ascertain the eventual alteration in the chemical composition during the process of cooling, a hermetically sealed zinc case should at the same time be filled with a quickly cooled sample of masse-cuite, fixed to the axis of the malaxeur, and then allowed to cool with the syrup; in this way one guards against the possibility of some of the syrup of malaxage getting into the sample whereby the figurative results would have been altered. In this manner it is possible to establish the nature of the transformations with some certainty. The runnings from the second products were treated in the same way; those from the third were unfiltered and boiled without the addition of lime. The resulting molasses were after dilution well filtered over char and concentrated to about 78° Brix.

The following table gives an idea of the composition of a portion of these products:—

II.

Second Product Boiled with Direct Steam.

Cooling temperature, 60°C.

	Green Syrup. Boiling with lime. Before.	After.	After filtration.	*Masse-cuite* Rapidly cooled.	Cooled in Malaxeur.
Direct polarization	99·13	99·38	99·75	99·35	99·17
Clerget ditto	98·12	98·13	98·58	99·00	98·60
Ash	0·09	0·14	0·09	0·09	0·09
Organic non-sugar—I.	0·78	0·48	0·16	0·36	0·74
Organic non-sugar—II.	1·79	1·73	1·39	0·91	1·30
10 gr. reduced mgr. Cu.	144·1	139·6	137·2	107·6	118·8

III.

PRODUCT BOILED WITH WASTE STEAM, GRAINED WITH LIVE STEAM.

Cooling temperature, 30° C.

Direct Polarization	98·58	99·1	98·68	98·82	89·83
Clerget ditto	97·53	97·45	97·39	97·03	97·03
Ash	0·23	0·25	0·25	0·25	0·23
Organic non-sugar—I.	1·19	0·65	1·07	0·93	0·94
Organic non-sugar—II.	2·24	2·30	2·36	2·72	2·74
10 gr. reduced mgr. Cu.	235·5	250·9	235·6	187·8	202·4

From all these figures we see that the decomposition of sugar goes on as long as the boiling is conducted at high temperature; that in the third product under a lower temperature the differences in the chemical nature of the masse-cuites under rapid or slow cooling are practically nil. We see furthermore that the extent of the difference between direct polarisation and the Clerget figure increases steadily with each boiling. The proportion of reducing substances is remarkable. It is noticeable that with the second as well as the third products they have diminished distinctly, and under slow cooling have increased very little if at all. The fourth product brings this out still more strikingly.

IV.

PRODUCT BOILED WITH EXHAUST STEAM, DIRECT STEAM ONLY USED FOR GRAINING.

Cooling temperature 38° C.

	Syrup.	Masse-cuite.
Sugar by direct polarisation	97·70	98·04
Sugar according to Clerget	95·86	94·81
Ash	0·47	0·47
Organic non-sugar—I.	1·83	1·49
Organic non-sugar—II.	3·65	4·72
10 gr. reduced mgr. of Cu	374·0	367·0

In any case the direct polarisation alone must result in a false idea, especially as regards the calculation of the quotient of real purity by it and the water content. All the figures go to show that even under low boiling temperatures the after-products are distinctly affected. But what the nature of these existing bodies partakes of cannot be established with any certainty at the present day, and the solution of the question may well have to wait a considerable time yet. One thing at least is certain; that the decompositions occur not only with the formation of glucose and levulose, but also with dextrine under little known reactions; and that our knowledge of these bodies and their nature is still of the scantiest.

At each boiling caramelization takes place which, independent of the alkality or acidity of the juices and masse-cuites, increases the higher the temperature at which one works. This caramelization has some influence on the colour, nevertheless not so much as is often supposed. In the general manufacture of sugar

comparatively little caramel is produced and plenty of colouring matter produced by the action of lime on non-sugar; this latter is often mistaken for a carameline body. This view is held by Pellet but controverted by Fradiss. The former bases his view on the fact that in most molasses (here, of beets) no reducing bodies are found, whereas caramel is one. Likewise in refinery molasses little caramel exists. Another reason for this is the action of basic acetate of lead on the caramel. The latter is not precipitated by this reagent, but is by ammoniacal acetate of lead. On the other hand, the colouring matters in the molasses are almost totally precipitated by ordinary acetate of lead, whereas the caramel remains in solution and is noticeable by its reducing power. In order to estimate this power the writer undertook some experiments with pure caramelan solutions. These experiments showed that the reducing power of caramel is extremely small. Two minutes' heating resulted in 50 c.c.m. of a 1% solution reducing 150 mg. of copper; the proportion of copper reduced to the reducing caramelan is consequently as 1 : 3·3. This shows that the reducing power is very small. Experiments carried out with solutions of 0·1% to 1% caramelan gave under two minutes' heating constant reducing powers, increasing in exact proportion to the concentration, so that the estimated values drawn up on a system of co-ordinates lie in a straight line. The reducing power increases with the duration of boiling.

For example:—

Under	2	minutes' boiling	50 mg. caramelam	give	15	mg. Cu.
,,	5	,,	,,	,,	17	,,
,,	8	,,	,,	,,	19·9	,,
,,	10	,,	,,	,,	23·8	,,

From these figures we see that the proportion of caramelan in a solution exercises its influence on the estimation of the amount of invert sugar present, since caramelan has a slight power of reducing and is not precipitated with lead acetate.

The question now arises: is caramelan a substance of definite chemical composition? If we turn to existing literature on the subject, we shall find various contradictory opinions. These arise from the dissimilar methods of preparation; for if we work on the same lines, we ought to achieve the same results. If we chose 170-180° as the temperature of caramelisation, we have only to reckon on a loss of water of about 12% which agrees well with our calculations. An estimation of molecular weight which I carried out on the cryoscopic method gave 303·9 as the molecular weight. According to the formula $C_{12}H_{18}O_9$ it works out at 306·18 which is very similar. In the year 1899 I prepared the lead salts and tetracetic derivatives of caramelan, from which composition I formed the above formula. I believe, from what I have just stated that the formation of caramel

under a constant temperature of 170-180° follows simply from loss of water.

$$C_{12}H_{22}O_{11} = C_{12}H_{18}O_9 \text{ plus } 2H_2O.$$

About two years ago I made a preliminary communication on the hydrolysis of caramelan. I was able to show that when acted on by dilute acids it gave amongst other substances a hexose. I was not then able to isolate it in a pure form; but I have just lately succeeded in so doing. One easily obtains pure products by employing a 3% sulphuric acid. It comprises: 1. A hexose; 2, levulic acid; 3, humic bodies.

The caramelan therefore exists as a definite carbon hydrate. A more detailed description of its method of preparation and the ascertained analytical data would be out of place here for lack of time; but it will form the object of a future communication from the writer to the Zeitschrift.

The humic bodies have been produced in the proportion of 15%. They are composed of 54·8% C, 5·48% H, and 39·72% O, from which one calculates the general formula $(C_9H_{11}O_5)$. This new hexose is present as a substance similar to glucose, it crystallizes out of water in the form of a hydrate and has as point of fusion 93° and upwards to 110° when it is fully liquid; in methylated alcohol under the form of anhydride with a corrected fusion point of 148°

For the hydrate the specific rotation is about $[\alpha]\ D = 48{\cdot}03°$
For the anhydride .. .. $[\alpha]\ D = 52{\cdot}60°$

figures corresponding to those of glucose.

The osazone of the hexose crystallizes in fine needles in an annular group with a melting point of 201·9°, which is somewhat lower than the melting point of glucazone. Mention might be made here of a determination I made whilst studying the re-crystallisation of osazone: on dissolving with alcohol and precipitating with plenty of water, I obtained only a small quantity of the original matter; it was under these conditions decomposed by the water.

An identical determination was made by Sundwik on a hexose much less perfectly characterised which he had extracted from humble-bee honey. Another characteristic under which it differs from glucose is that on oxidation with bromide it gives rise to pentaoxicapronic acid, the lime salt of which has a higher rotatory power than has the lime salt of glucinic acid. Whether the hexose obtained from caramel is identical with glucose or is of stereoisomeric composition (a possible theory when we admit the doctrine of Tollens and Skraup as to the symetry of the fifth atom of carbon granting its oxyethylenic nature) cannot yet be decided.

It must be understood that none of the conclusions with regard to these experiments can be considered completed or final. The reducing power of hexose on Fehling's Solution is more feeble than that of

glucose—129 mg. only give 240 mg. of copper, whilst the glucose gives 250 mg.

In any case the writer trusts he has shown that caramelisation is not so great in normal procedure as has hitherto been considered the case, and that on the application of higher temperatures many other dextrine formations enter in. With a good circulation of the massecuite in the vacuum pan the sugar mass is too short a time in contact with the steam coils as to allow more than the smallest amount of caramel to form, and the losses thus caused are quite insignificant.

SUGAR MAKING IN NATAL.

By George Griffith.

It is a very pleasant land, the coast-strip which stretches north-east from Durban to the mouth of the Tugela. It is not literally a land flowing with milk and honey, although there is quite a close alliance between its products and those of ancient Canaan, for its fertile acres are devoted to the production of sugar and tea—sugar to the south, and tea to the north, just a few miles nearer to the equator.

What follows here is concerned entirely with sugar planting and production as I have just seen it on the Natal estates, the centre of which is the Mount Edgecombe sugar factory. The whole estate has an area of about 20,000 acres, and half of this is under productive cultivation. The actual yield is one-and-a-half tons of sugar per acre, which works out at from 5,000 to 6,000 tons for each crushing season.

To begin at the beginning—the cane top, that is to say, that portion of the sugar cane which is used for re-production, a length of about one foot between the head, which is the softest part, and the hardest part which is used for crushing is cut out and planted, as I believe no other of the fruits of the earth is planted, that is to say, horizontally instead of vertically, in holes opened in the cane-rows five feet apart. This cane top, as it is technically called, although it is not so, has buds something like the eye of a seed potato, at intervals of about an inch alternately placed on either side, and it is from these that the new cane springs and grows up into the stools or clumps of canes.

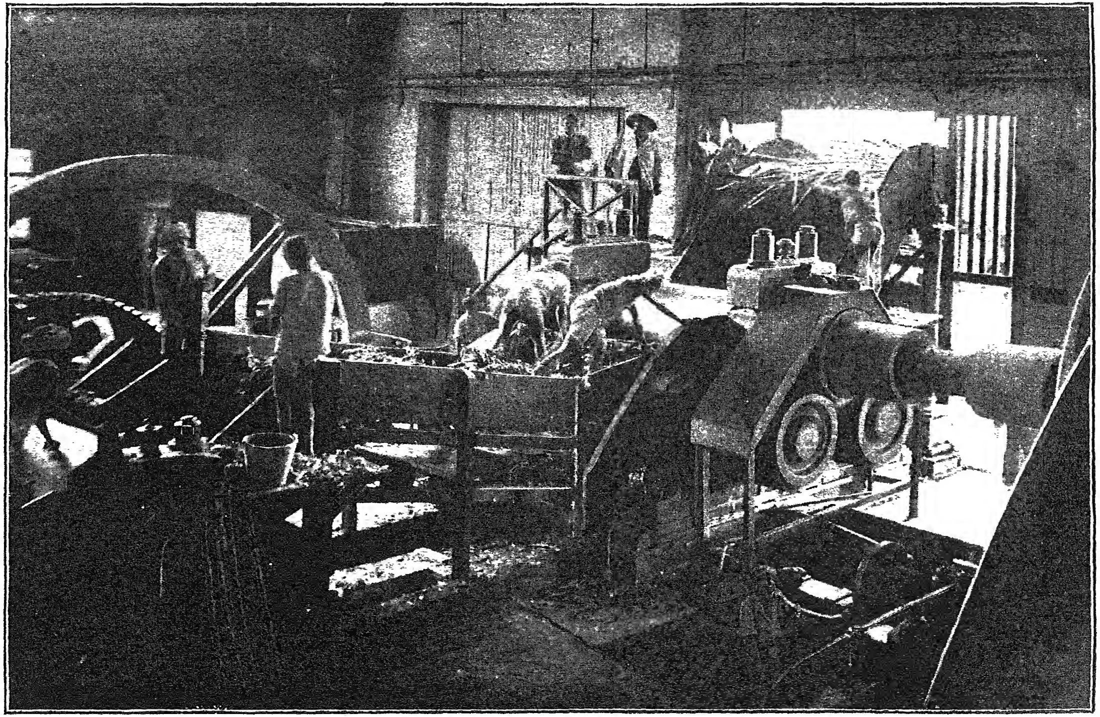
In a new cane plantation it takes two years for the first crop or "plant cane" to come to maturity. The second cutting is known as the "first ratoon," and the third as the "second ratoon." The first ratoons mature in eighteen months, and the second in the same time. When this crop has been gathered, the roots are dug up and fresh tops planted in between the old rows. The fields are fertilised with a mixture of stable manure and the ashes of burnt cane which contain a large percentage of nitrate of potash. From twenty to thirty tons

of this fertiliser are used per acre. The Natal sugar belt being semi-tropical is at a certain disadvantage in comparison with tropical sugar countries, as there the cane matures in from 9 to 12 months instead of two years.

So much for the cultivation. The canes are cut with a huge knife somewhat resembling the Spanish machete, which is used for the same purpose in the cane fields of South America. The cut canes are loaded on carts and taken to the tramways which intersect the estate. These bring them down to the mill where they are off-loaded on to an inclined moving platform, which carries them up to the top of the crushing plant. This consists of two mills, each of three rollers. The rollers of the first one weigh ten tons each, and those of the second six tons. From the first mill about 80% of the total juice is obtained, and from the second about 20%. I may mention incidentally that the actual economy of the double over the single crushing machines amounts to from 15% to 20% of actual cane juice. The waste passes up a shoot, almost dry, and is immediately thrown into a pit on to which the furnaces open, and so the crushed cane furnishes within three or four minutes the motive power to the two engines of 80 and 35 H.P. which drive the crushing mills, and to the large number of other engines and pumps too numerous to specify, employed in bringing the juice from its initial stage to that of the final sugar one. Sugar making, is, in fact, quite an ideally economical operation from the engineer's point of view. There is absolutely nothing lost, for the waste from the crushed cane is quite sufficient to keep steam up in the five multi-tubular boilers which actuate all the engines, pumps, &c., and the water used in the various processes is pumped by one of these same engines and pumps up to the top of a five-storied open structure whence it trickles down from perforated pipes through layers of twigs into a tank, which it reaches cold enough to be re-employed for purposes of condensation.

Not even the waste water containing the acids and colouring matters removed in the process of purifying the juice is wasted. Instead of being allowed to run off into streams which it would pollute and poison—as is done on some estates—it is pumped into tanks three-quarters-of-a-mile away, and nearly 200 feet higher than the factory, and from these it is distributed as a fertilizer over waste lands, which after undergoing this treatment is found to give an increased yield of cane, is this refuse when stagnant acquires a very bad odour, this is a sanitary as well as a profitable measure.

The juice falls from the rollers into a tank and then passes through a sieve which cleanses it from small particles of crushed cane. It is then pumped up into a small tank about fifteen feet higher than the mill, and is passed in thin streams through what is called the sulphur column. The object of this process is to bring it into contact with sulphur fumes which decolorise it, and at the same time prevent



SUGAR MAKING IN NATAL.

fermentation. From the sulphur column it is run off into measuring tanks, and thence into the clarifiers, of which there are six in use.

From the clarifiers the juice passes into the "subsiders," which are a Mauritian invention, and in these the action is purely mechanical, as the name implies—just the subsidence of the sediment. From these the clear juice is pumped up into six square tanks filled with Taylor bag filters; each tank contains 36 of them. Next come the "triple-effets." These consist of two sets of domed copper receptacles, three in each set, connected by steam pipes. About 75% of what is called the "body" of the juice is evaporated down from a density of 9° Baume to 23° or 24°.

From the evaporators the condensed syrup passes into the settling tanks, and thence into three vacuum pans where the crystallisation or change from syrup to sugar takes place.

The resulting masse cuite is taken to large, oblong, wooden coolers arranged along one side of a long room on the other side side of which is a row of sixteen centrifugals. Into these the masse is put after it has undergone further crystallisation and hardening of the grain in the wooden coolers. This hardening of the grain is a very important part of the science and art of sugar making, as it is quite essential to a large first product. It gets so hard in the coolers that it has to be broken up in what is known as a pug mill before it can be put into the centrifugals.

The white crystals taken from the centrifugals form what is called the "first product." They are the highest quality of sugar and represent 67% of the total produce. The syrup is re-treated by being put through exactly the same process, and the result is, the "second product" known to commerce as light, yellow sugar. The syrup which remains after this process may be treated yet a third time, and the result of this will be the "third product," consisting of coarse brown sugar. These after-products are not treated at Mount Edgecombe. They are sent to the Company's refinery at South Coast Junction where they are turned into white crystal and cube sugar, and golden syrup. The first quality after going through a final process of sifting is packed in 70 lb. bags or "pockets."

All the labour on the estate, with the exception of overseeing and clerical work, is done by coolies and natives, and the writer naturally took advantage of such a good opportunity of discussing the much vexed and often hotly argued question of coolie labour with the manager, a gentleman who has had many years' practical experience of the subject.

There are about 1,100 male Indians on the estate, which means a total Indian population of about 2,300 men, women, and children. There are also about 200 African natives. The Indians come under indentures which last five years. At the end of that time they must

either re-indent for two years or return to India, unless they are prepared to pay a yearly license of £3 which entitles them to complete freedom, and the right to take up land for cultivation.

It is hardly necessary to say that a considerable proportion of the more intelligent and energetic gladly avail themselves of these privileges, and most of them do well, especially as growers of vegetables and fruit for the market. During the period of indenture they are paid 10s. a month for the first year, and 1s. a month more for each successive year. They have food, housing, and medical attendance free. In fact everything is provided for them except clothing.

It is believed at Mount Edgecombe, as it is in all similar industrial centres, that Coolie labour is absolutely essential to the carrying on of the industry. The men, when properly managed, are steady, sober and industrious, and, as far as could be seen, perfectly content. As far as possible the system of piece work is practised, that is to say, a man is given a certain amount to do, and when that is done the rest of his time is his own. The system works exceedingly well, and reduces friction between master and man to a minimum.

There really does not seem to be any practical alternative to Coolie labour, as far as sugar producing and tea cultivation are concerned. White man either cannot or will not do the work, except at prices and under conditions which would be economically impossible. The African native is equally hopeless, simply because as soon as he has made what he considers enough money to keep him in idleness for a few months he gives notice and walks off, and when he says he is going no power on earth can stop him. You may offer him double or treble wages without avail. As he usually manages to take this fancy about the busiest time, the ruin that he could cause by throwing up his work, as he would, just when the canes are ready for cutting and crushing may be easily imagined.

So far the Coolie system has worked well both for master and man, there is no hardship whatever involved in it, and it very frequently paves the way to an independent competence which could hardly be won otherwise. The suggestion made by its opponents, who are either uninformed sentimentalists or labour agitators, that indenture means a form of slavery is all nonsense. There is no more compulsion about it than there is in our own system of apprenticeship at home. The only difference is that, in this case the apprentice is a grown man; but in this connection it must not be forgotten that the Indian of this class never grows up to the mental stature of the European. It is absolutely necessary to put him through a course of steady, sustained industry under kindly but firm supervision before he is morally or intellectually capable of entering the commercial or industrial world as a free and responsible citizen of the Empire. That such a large

proportion of Coolie ex-labourers have established themselves in positions of respectable competence after passing through their period of training is, after all, the most conclusive argument as to the humanity and the efficiency of the system.

Certainly, from what the writer has seen of the working of it, he can say that it would be quite sufficient to satisfy any student of the subject who approached the question free from either sentimental or economic prejudice. The attitude of the labour agitator is of course easily understood. In Australia he is having his way in the matter. All economists will await the result of the experiment with interest. At present it must be confessed that the only effect produced is visible in decreasing revenue and ever increasing deficits and public debt. It is certainly to be hoped that until the results of the Australian experiment are clearly available no attempt will be made to alter the present conditions of Coolie labour in South Africa.

There is another phase of the question which is well-deserving of attention from both the economist and the humanitarian. A very large proportion of the Coolies employed in the sugar and tea industries of Natal are recruited from the poorest and most severely famine-stricken districts of India, and so terrible is their condition when they arrive that in many cases from six to eighteen months elapse before they are physically fit for work. All this time they are, of course, maintained by the planter, who thus not only trains them to work but feeds them up to a standard of health and strength which is practically unknown to the classes to which they belong in their own country.

Indeed, so beneficial is the training which is made possible by the better food and more sanitary conditions that it is quite conceivable that these Indian subjects of His Majesty may in future become the principal colonists of those tropical and sub-tropical regions of British Africa whose climatic conditions make profitable white labour an impossibility. One more fact that they take so kindly to agriculture after the expiration of their indentures is in itself a reason for believing that such a proposition is within the range of practical economics.

A new process of clarifying saccharine or other solutions has just been patented by Mr. E. W. Deming, of New York and New Orleans. According to this process the saccharine solution brought from any source of supply is carried along a passage, beneath which is a series of successive collecting chambers, the rate of flow, temperature, and pressure being so regulated that the heavy impurities subside into the first collecting chamber, while each successive chamber receives lighter materials.

THE PURITY OF LOW GRADE MOLASSES.

By Ernest E. Hartmann.

It is still customary in many cane sugar factories to determine the sucrose in molasses by single polarisation after clarification with more or less subacetate of lead. Although it is quite generally realised that this method does not give the actual amount of sucrose, it is still employed on account of its simplicity and owing to the belief that the analysis, if carried out under similar conditions, will give results which, if not absolutely correct, are of use for comparisons. This belief can be very misleading; for instance, although the waste molasses of Factory A have a purity of 35 and those of Factory B of 40, as found by single polarisation carried out under identical conditions in both cases, it is yet possible, that the molasses of Factory B contain the same amount of sucrose or even less than that of Factory A, if the difference in the glucose contents is a very marked one. Add to this, that the conditions under which the analyses are made in the different laboratories are by no means identical, and it will be conceded that the value of such data as criterion for the efficiency of the boiling department is rather problematical. This is illustrated clearly by the results, recorded below, of some experiments made with Hawaiian waste molasses.

The factors, which render the method inaccurate are the lævo-rotation of the reducing sugars and the volume and composition of the lead-precipitate. The former is compensated by inversion according to Clerget's classical method, for the latter there is a simple way of making a correction, although this is not generally done. That without such a correction the subsequent calculations are based on too concentrated a solution, is evident. Wiechmann made some interesting studies on these precipitates and their influence on polariscope readings. (They were embodied in a paper read last June before the Congress of Applied Chemistry.) He restricted his investigations to sugars and molasses, the lowest of which contained 75% of sucrose.

Here we have to deal with molasses containing but 30% of sucrose and consequently a much larger proportion of non-sugars.

Another error, as great as the one due to displacement, is caused by the precipitation of levulose as levulosate of lead. The proportion between the dextrose and levulose in the solution being disturbed by the elimination of part of the levulose, the dextro-rotatory power of the molasses is increased. Again an old-established fact; but the extent to which the readings of molasses, such as we are dealing with here, is influenced, is not generally realised. In order to illustrate

this, one-third the normal quantity of waste molasses in 100 c.c. flasks was clarified with varying amounts of basic lead-acetate of 1·25 specific gravity prepared according to the formula given in Tucker, and also with a 25 % solution of neutral lead-acetate. The polariscope readings of the filtrate are recorded below (calculated to normal quantity) :—

k	Subacetate of lead	50 c.c. ..	36·00
i	,, ,, ...	40 ,, ..	35·34
h	,, ,, ...	30 ,, ..	33·96
g	,, ,, ...	20 ,, ..	31·25
f	,, ,, ...	10 ,, ..	28·29
e	,, ,, ...	5 ,, ..	26·76
d	,, ,, with correction: $e - (f - e)$	=	25·23
c	Neutral acetate of lead	5 ,, ..	25·14
b	,, ,, ...	2·5 ,, ..	24·90
a	,, ,, with correction $b - (c - b)$	=	24·66
l	Percentage of sucrose found by Clerget's method (clarification with 5 c.c. neutral acetate)		32·58
m	Percentage of sucrose found by Fehling's method		31·50
n	Glucose percentage		23·16
o	Brix ° dilution 1 : 3		91·05
p	,, corrected for error caused by dilution		88·7
q	,, actual (representing percentage total solids)		81·2
r	Water		18·8
	Purity, actual, $l \times 100 \div q$		40·1
	,, as given usually, $f \times 100 \div o$		31·1

This shows how vastly different values can be obtained for the purity. *a*, *b*, *c*, *d*, *e*, *f*, or even *g* or *l* or *m* may be divided by *o*, *p*, *q*, or a figure higher than *o*, if more water is used for diluting the molasses. Anything between the two extremes $l \times 100 \div q = 40·1$, and $a \times 100 \div o = 27·1$, may be found according to the preference of the operator, surely a very wide range. The true purity, *i.e.*, the quotient of the sucrose and the total solids is in this case 40·1, a figure one-third higher than the quotient of polarisation and Brix, commonly determined to represent the purity (in this case about 30).

In the case of molasses of higher purity the differences are less marked. Below is the average of the results of a number of analyses of No. 2 molasses :—

Subacetate of lead	40 c.c. ..	43·20
,, ,, ...	30 ,, ..	43·28
,, ,, ...	20 ,, ..	42·16
,, ,, ...	10 ,, ..	39·24
,, ,, ...	5 ,, ..	37·20
,, ,, with usual correction for volume of precipitate	..	35·16

Neutral acetate of lead..	5 c.c. ..	35·20
,, ,, ...	2·5 ,, ..	35·04
,, ,, with usual correction for volume of precipitate..	..	34·88
Percentage of sucrose found by Clerget's method (clarification with 5 c.c. neutral acetate)		39·84
Percentage of sucrose found by Fehling's method ..		38·56
Glucose percentage..		17·60
Brix, dilution 1 : 3		89·00
,, Actual (representing percentage of total solids)		81·0
Water..		19·0
Purity, actual, $39·84 \times 100 \div 81·0$		49·2
,, as given usually, $37·20 \times 100 \div 89·0$		41·8

Any attempt to utilise these data to establish a constant factor for correction would be futile, as the composition of the molasses varies with different varieties of cane, localities, maturity, treatment in factory, &c. There is but one way of finding the exact amount of sucrose in the molasses. Unfortunately, Clerget's method requires too much time to be suitable for ordinary factory routine work. In order to overcome this difficulty a weekly sample of molasses should be made up, in which, at the end of the week, the sucrose would be determined according to Clerget's method, also in the ordinary way with a constant quantity of subacetate of lead. The water and the glucose should also be determined in this sample, as well as the density according to Brix. For the daily control work the customary method with subacetate would be adhered to, care being taken that the quantities of molasses weighed, as well as the quantities of the re-agent, are the same. The results thus obtained would fulfil their object of furnishing a comparison between individual strikes. Should it be desired, the correction found by analyses of the weekly sample could, at the end of the week, be applied to the individual results.

The dilution method for the correction for precipitate compensates the displacement only, not taking any account of the composition of the precipitate. In consequence about half the error is left unchanged. A better formula is the one employed in the above tables, although it is not entirely satisfactory either, being based on the supposition that the precipitate caused by the first 2½ (5) c.c. is similar in quality and quantity to that caused by the second 2½ (5) c.c. That the two are not exactly the same is shown below.

A series of experiments were made with a view to ascertain the relative importance of the two causes of the precipitate error, *i.e.*, the displacement of liquid by the precipitate and the elimination of levulose. 6·5 grammes of molasses dissolved in a 100 c.c. flask were precipitated with 10 resp. 20 c.c. of subacetate, the precipitate washed

by decantation, dissolved in acetic acid and filtered. The readings were as follows :—

	1	2	3	4	5	6	Average.
Filtrate from basic precipitate—							
20 c.c. subacetate ..	8·5	8·4	8·0	7·6	8·05	8·46	8·17
10 c.c. ,, ...	7·6	7·5	7·2	6·8	7·12	7·55	7·27
Increase in polarisation caused by the second 10 c.c. of subacetate ..	·9	·9	·8	·8	·93	·91	·90
Acid solution of precipitate (reading correct for temperature—							
20 c.c. subacetate ..	1·20	1·02	·98	·97	1·05	·97	1·03
10 c.c. ,, ...	·70	·58	·54	·66	·54	·48	·58
Lævo-rotation caused by the second 10 c.c. of subacetate	·50	·44	·44	·31	·51	·49	·45

This indicates that about half of the total error is due to the elimination of levulose. It also shows that the first 10 c.c. of the subacetate precipitate a larger amount of levulose than the subsequent 10 c.c. Samples of No. 2 molasses behaved similarly, and showed the decrease in the later fraction of precipitates even more distinctly.

	Polarisation. Basic solution.	Acid solution.
20 c.c. subacetate	10·18	·85
10 c.c. ,, ...	9·37	·51
5 c.c. ,, ...	9·00	·28

The redissolved precipitate of the first 5 c.c. caused a lævo-rotation of ·28, the second 5 c.c. ·23, and the subsequent 10 c.c. only ·34. Thus, by applying either formula for the correction for precipitate, the deduction made is inadequate. This is borne out by the difference between the corrected readings *a* and *d*. It is for this reason preferable to use neutral acetate with Clerget's test. The error due to volume is then so small, that even if it were neglected, no great error would ensue.

For the calculation of the purity it is necessary to know the percentage of water. It would, after all, matter but little, for comparative purposes, whether the degree Brix as indicated by the spindle and the percentage of total solids agreed or not, if the specific gravity of the components of the molasses were constant. This is however not the case. Of two samples of molasses both containing 18% of water, the one may show 85, the other 90 or more degrees Brix. The direct determination of the water takes a little too much time to recommend itself for general adoption in control work; it may well be limited to the periodical average sample. It is practically impossible to dry low grade molasses such as our waste products to a constant weight at a temperature which admits of the operation being finished within a reasonable time. The most satisfactory results we

obtained by drying the molasses in a current of dry air in the following manner:—

Two grammes of filter paper are crumpled, tied with thin wire into a roll and dried. This is weighed in a tared test tube 5 in. × 1 in. The paper is then removed and about two grammes of molasses are weighed in the tube and mixed with 2 c.c. hot water. The paper replaced in the tube evenly absorbs the whole of the liquid. The tube is then placed in a water bath. A double perforated stopper, with which it is provided, allows a slow current of air, previously dried over calcium chloride or sulphuric acid, to be drawn through. If the water is kept boiling the operation is finished in 2½ hours. In order to ascertain the moment when all the water has escaped (the further diminution in weight is due to the volatilization of other components of the molasses only), parallel tests were made with two grammes of molasses and two grammes of sugar under exactly the same conditions. The weights found are as follows:—

	Molasses.	Sugar.
Weight of tube and paper	18·068	20·821
,, molasses	2·034	2·140
Total before drying.	20·102	22·961
After 1½ hours	19·751	22·912
,, 2 ,,	19·734	22·906
,, 2½ ,,	19·725	22·897
,, 3 ,,	19·723	—
,, 3½ ,,	19·722	22·898
,, 5 ,,	19·716	22·898
,, 6 ,,	19·715	22·898
,, 7 ,,	19·713	—
,, 8 ,,	19·710	—
,, 10 ,,	19·703	22·897
,, 12 ,,	19·701	22·896
,, 14 ,,	19·695	22·898
,, 18 ,,	19·691	22·898
,, 20 ,,	19·688	22·897
,, 24 ,,	19·685	22·897

$$\text{Percentage of water} = \frac{20{\cdot}102 - 19{\cdot}725}{2{\cdot}034} \qquad \frac{22{\cdot}961 - 22{\cdot}897}{2{\cdot}140}$$

$$= 18{\cdot}5 \qquad {\cdot}3$$

The weight of the tube with the sugar remained practically constant after 2½ hours, and the molasses also had evidently lost all its water in the same time. The loss in weight sustained in 2½ hours at the temperature of boiling water, the other conditions as described being adhered to, may therefore safely be taken to represent the water in the molasses.

DEDUCTION OF FORMULÆ FOR CALCULATION OF CAPACITIES AND HEATING SURFACES OF SINGLE OR MULTIPLE EFFECTS.*

By Edw. P. Eastwick, Jr., C.E., Ph.B.

Continued from Page 445.

Let us now collect together the several new formulæ deduced during the foregoing criticism of Jelinek's and Déon's formulæ, which are applicable to the calculations of a simple or multiple effect of any number of bodies, concentrating solutions whose vapours are water, and are the following:—

$$Q_x = \frac{F_x a_x (T_x - \theta_x) + \dfrac{G_x s_x (\theta_x - t_x)^2}{2\left[T_x - \dfrac{\theta_x + t_x}{2}\right]} + \dfrac{\Sigma y_x (\theta_x - t_x)}{2\left[T_x - \dfrac{\theta_x + t_x}{2}\right]} + \Delta_x}{1115{\cdot}2 - {\cdot}708 T_x} \qquad (A_a)$$

$$Q_x = \frac{p_x (1115{\cdot}2 - {\cdot}708\theta_x) + G_x s_x (\theta_x - t_x) + \Delta_x + \Sigma_x}{1115{\cdot}2 - {\cdot}708 T_x} \qquad (AA_a)$$

$$p_x = \frac{F_x a_x (T_x - \theta_x) - G_x s_x (\theta_x - t_x)\left[\dfrac{T_x - \theta_x}{T_x - \dfrac{\theta_x + t_x}{2}}\right] - \Sigma_x + \dfrac{\Sigma y_x (\theta_x - t_x)}{2\left(T_x - \dfrac{\theta_x + t_x}{2}\right)}}{1115{\cdot}2 - {\cdot}708\theta_x} \qquad (B_a)$$

from (A_a)—

$$F_x = \frac{Q_x (1115{\cdot}2 - {\cdot}708 T_x) - \dfrac{G_x s_x (\theta_x - t_x)^2}{2\left(T_x - \dfrac{\theta_x + t_x}{2}\right)} - \dfrac{\Sigma y_x (\theta_x - t_x)}{2\left(T_x - \dfrac{\theta_x + t_x}{2}\right)} - \Delta_x}{a_x (T_x - \theta_x)} \qquad (C_a)$$

from (B_a)—

$$F_x = \frac{p_x (1115{\cdot}2 - {\cdot}708\theta_x) + G_x s_x (\theta_x - t_x)\left[\dfrac{T_x - \theta_x}{T_x - \dfrac{\theta_x + t_x}{2}}\right] + \Sigma_x - \dfrac{\Sigma y_x (\theta_x - t_x)}{2\left(T_x - \dfrac{\theta_x + t_x}{2}\right)}}{a_x (T_x - \theta_x)} \qquad (CC_a)$$

To the above formulæ may be added the following special formulæ, which, as will be seen later, are derived therefrom:—

*Owing to a difference of opinion we have had with the Author, it is advisable to point out here that in this paper the decimal is represented by a point placed about the middle (·5). This is the usual method in English practice and it is never placed on the line as appears to be done in some other countries.

(See adjacent inset, page 545a.)

$$p_{II} = \frac{F_I a(T_I - \theta_I) - G_I s_I(\theta_I - t_I)\left[\dfrac{T_I - \theta_I}{T_I - \dfrac{\theta_I + t_I}{2}}\right] + (G_I - p_I)s_{II}(T_I - \theta_I) - (\Sigma_I + \Sigma_{II} + \Delta_{II}) + \dfrac{\Sigma y_I(\theta_I - t_I)}{2\left(T_I - \dfrac{\theta_I + t_I}{2}\right)}}{1115{\cdot}2 - {\cdot}708\theta_{II}} \qquad (B_{II})$$

$$p_{III} = \frac{F_I a(T_I - \theta_I) - G_I s_I(\theta_I - t_I)\left[\dfrac{T_I - \theta_I}{T_I - \dfrac{\theta_I + t_I}{2}}\right] + (G_I - p_I)s_{II}(T_I - \theta_I) + (G_I - p_I - p_{II})s_{III}(T_I - \theta_I) - (\Sigma_I + \Sigma_{II} + \Sigma_{III} + \Delta_{II} + \Delta_{III}) + \dfrac{\Sigma y_I(\theta_I - t_I)}{2\left(T_I - \dfrac{\theta_I + t_I}{2}\right)}}{1115{\cdot}2 - {\cdot}708\theta_{III}} \qquad (B_{III})$$

$$p_{IV} = \frac{F_I a(T_I - \theta_I) - G_I s_I(\theta_I - t_I)\left[\dfrac{T_I - \theta_I}{T_I - \dfrac{\theta_I + t_I}{2}}\right] + (G_I - p_I)s_{II}(T_I - \theta_I) + (G_I - p_I - p_{II})s_{III}(T_I - \theta_I) + (G_I - p_I - p_{II} - p_{III})s_{IV}(T_I - \theta_I) - (\Sigma_I + \Sigma_{II} + \Sigma_{III} + \Sigma_{IV} + \Delta_{II} + \Delta_{III} + \Delta_{IV}) + \dfrac{\Sigma y_I(\theta_I - t_I)}{2\left(T_I - \dfrac{\theta_I + t_I}{2}\right)}}{1115{\cdot}2 - {\cdot}708\theta_{IV}} \qquad (B_{IV})$$

$$F_{II} = F_I - \frac{G_I s_I(\theta_I - t_I)}{a\left(T_I - \dfrac{\theta_I + t_I}{2}\right)} - \frac{\Sigma_I + \Delta_{II}}{a(T_I - \theta_I)} + \frac{\Sigma y_I(\theta_I - t_I)}{2a\left(T_I - \dfrac{\theta_I + t_I}{2}\right)(T_I - \theta_I)} \qquad (C_{II})$$

$$F_{III} = F_{II} + \frac{(G_I - p_I)s_{II}}{a} - \frac{\Sigma_{II} + \Delta_{III}}{a(T_I - \theta_I)} \qquad (C_{III})$$

$$F_{IV} = F_{III} + \frac{(G_I - p_I - p_{II})s_{III}}{a} - \frac{\Sigma_{III} + \Delta_{IV}}{a(T_I - \theta_I)} \qquad (C_{IV})$$

Also the general formula, deduced hereinafter, for calculating directly the capacity of a single or multiple effect, up to and including a quadruple, concentrating a solution from one density to another, viz:—

$$G_I = \frac{J\left[F_I a(T_I - \theta_I) - \Sigma_I + \dfrac{\Sigma y_I(\theta_I - t_I)}{2\left(T_I - \dfrac{\theta_I + t_I}{2}\right)}\right] - {\cdot}99\,(N - 1)\left[(\Sigma_{II} + \Delta_{II}) + \dfrac{N-2}{N-1}(\Sigma_{III} + \Delta_{III}) + \dfrac{(N-2)(N-3)}{6}(\Sigma_{IV} + \Delta_{IV})\right]}{\left(1 - \dfrac{B_I}{B_X}\right)(1115{\cdot}2 - {\cdot}708\theta_I) - (N-1)(T_I - \theta_I)\left[s - {\cdot}708\left(1 - \dfrac{B_I}{B_X}\right)\right] - \dfrac{(N-1)\,(N-2)\,(T_I - \theta_I)}{2}s\left[\dfrac{1115{\cdot}2 - {\cdot}708\theta_X - s\,(T_I - \theta_I)}{1115{\cdot}2 - {\cdot}708\theta_{II}}\right] + J\,s(\theta_I - t_I)\left[\dfrac{T_I - \theta_I}{T_I - \dfrac{\theta_I + t_I}{2}}\right]} \qquad (D)$$

In all of these formulæ similar quantities are represented by the same letters we have used in both Jelinek's and Déon's formulæ, viz.:—*

N = Number of bodies of multiple effect,
G_x = Quantity of liquid entering body in unit time, lbs.,
p_x = Quantity of water evaporated in any body in unit time, lbs.,
Q_x = Quantity of steam, or vapour, condensed in any body in unit time, lbs.,
θ_x = Temperature, Fahr., of liquid boiling in any body,
θ_N = Temperature, Fahr., of liquid boiling in last body,
T_x = Temperature, Fahr., of heating steam for any body,
t_x = Temperature, Fahr., of liquid entering any body,
B_I = Brix of original sugar solution entering first body of apparatus,
B_x = Brix of concentrated solution discharged from last body of apparatus,
s_x = Mean specific heat of liquid in any body,
s = Mean specific heat of liquid in all bodies of apparatus,
F_x = Heating surface of any body, sq. ft.,
α_x = Mean coefficient of heat transmission for any body, B.T.U.,
α = Mean coefficient of heat transmission for all bodies of apparatus, B.T.U., and

$$J = 1 + E_N[1115{\cdot}2 - {\cdot}708\theta_N - s(T_I - \theta_I)] - \frac{(N-1)(N-2)}{2}\ \frac{s(T_I - \theta_I)}{1115{\cdot}2 - {\cdot}708\theta_I}$$

in which, for ordinary conditions,

$E_N = (N - 1)({\cdot}00105 - {\cdot}000017N)$.

The exact values for E_N are:

For Single Effect = 0.

Double Effect $= E_D = \dfrac{1}{1115{\cdot}2 - {\cdot}708\theta_I}$

Triple Effect $= E_T =$

$$E_D + \frac{1}{1115{\cdot}2 - {\cdot}708\theta_{II}} - \frac{3s(T_I - \theta_I)}{(1115{\cdot}2 - {\cdot}708\theta_I)(1115{\cdot}2 - {\cdot}708\theta_{II})}$$

Quadruple Effect $= E_Q =$

$$\left\{\begin{array}{l} E_T + \dfrac{1}{1115{\cdot}2 - {\cdot}708\theta_{III}} - \dfrac{3s(T_I - \theta_I)}{(1115{\cdot}2 - {\cdot}708\theta_I)(1115{\cdot}2\ {\cdot}708\theta_{III})} \\ - \dfrac{s(T_I - \theta_I)}{(1115{\cdot}2 - {\cdot}708\theta_{II})(1115{\cdot}2 - {\cdot}708\theta_{III})} - 3\ \dfrac{s(T_I - \theta_I)}{1115{\cdot}2 - {\cdot}708\theta_I} \end{array}\right\}$$

Δy_x = Loss of heat in steam chamber of any body during time required to raise temperature of G_x quantity of liquid from $t_x°$ to $\theta_x°$, B.T.U.,

Σy_x = Loss of heat in vapour chamber during same period of time, B.T.U.,

* A Roman figure subwritten to a letter indicates that the quantity has reference to the body of the apparatus of corresponding number, the body in which the liquid first enters being distinguished as No. 1.

Δz_x = Loss of heat in steam chamber of any body during time required to evaporate p_x quantity of water, B.T.U.,

Σz_x = Loss of heat in vapour chamber during same period of time, B.T.U.,

$\Delta_x = (\Delta y_x + \Delta z_x)$ = Total loss of heat in steam chamber of any body in unit time, B.T.U.,

$\Sigma_x = (\Sigma y_x + \Sigma z_x)$ = Total loss of heat in vapour chamber of any body in unit time, B.T.U.

The values of Δ_x and Σ_x include losses of heat by conduction, radiation, convection, and contact of air, which vary according to material, covering, &c., and may be calculated by well known formulæ. Σ_x also includes the heat contained in the air and other gases removed from vapours of evaporation.

When using the formulæ it must be remembered, as previously explained, that $T_x - \frac{\theta_x + t_x}{2}$ *equals* $T_x - \theta_x$, *and both* $\frac{G_x s_x(\theta_x - t_x)^2}{2\left(T_x - \frac{\theta_x + t_x}{2}\right)}$ *and* $\frac{\Sigma y_x(\theta_x - t_x)}{2\left(T_x - \frac{\theta_x + t_x}{2}\right)}$ *equal* 0, *when* $\theta_x = t_x$ *or* $\theta_x < t_x$.

All of the above formulæ the writer believes to be original, and offers them as a means for making more accurate calculations of the single or multiple effect when evaporating sugar solutions* than by the use of either Jelinek's or Déon's formulæ. The formulæ are general and applicable under all conditions to the calculations of any single or multiple effect evaporating apparatus, in which the vapour of evaporation from one body provides the heating steam for the next, and in which also the liquid being evaporated passes from one body to the next in the direction of from the first to the last body.

The formulæ may also be made applicable to the calculations of a multiple effect in which the water of condensation of steam passes from one body into the next. In this case there is additional steam supplied to the steam chambers of all of the bodies after the first, caused by a re-evaporation of the water of condensation of the preceding body, which enters the next body at a higher temperature than the temperature of the steam in this latter body. The heat units furnished by this additional steam are, evidently, equal to the quantity of water of condensation entering the body multiplied by the difference between the temperature of the water of condensation and the temperature of steam in the steam chamber of body; for example, in the second body it would be equal to $Q_I(T_I - T_{II})$, or $Q_I(T_I - \theta_I)$, in the third body $(Q_I + p_I)(T_I - T_{III})$, or $(Q_I + p_I)(T_I - \theta_I)$, &c., and these quantities should be subtracted from Δ_{II}, Δ_{III}, &c., respectively, in all of the formulæ.

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* The formulæ are applicable only when the vapour evaporated is water and the total and latent heat is that of saturated steam.

$$p_{II} = \frac{F_I\alpha(T_I - \theta_I) - G_I s_I(\theta_I - t_I)\left[\dfrac{T_I - \theta_I}{T_I - \dfrac{\theta_I + t_I}{2}}\right] + (G_I - p_I)\, s_{II}(T_I - \theta_I) - (\Sigma_I + \Sigma_{II} + \Delta_{II}) + \dfrac{\Sigma y_I(\theta_I - t_I)}{2\left(T_I - \dfrac{\theta_I + t_I}{2}\right)}}{1115{\cdot}2 - {\cdot}708\theta_{II}}$$

and since, by formula (t), $p_{II} = G_I\left(1 - \frac{B_I}{B_x}\right) - p_I$, (B_{II}) becomes:

$$G_I\left(1 - \frac{B_I}{B_x}\right) - p_I = \frac{F_I\alpha(T_I - \theta_I) - G_I s_I(\theta_I - t_I)\left[\dfrac{T_I - \theta_I}{T_I - \dfrac{\theta_I + t_I}{2}}\right] + (G_I - p_I)\, s_{II}(T_I - \theta_I) - (\Sigma_I + \Sigma_{II} + \Delta_{III}) + \dfrac{\Sigma y_I(\theta_I - t_I)}{2\left(T_I - \dfrac{\theta_I + t_I}{2}\right)}}{1115{\cdot}2 - {\cdot}708\theta_{II}}$$

from which

$$G_I\left(1 - \frac{B_I}{B_x}\right)\left(1115{\cdot}2 - {\cdot}708\theta_{II}\right) + G_I s_I(\theta_I - t_I)\left[\frac{T_I - \theta_I}{T_I - \dfrac{\theta_I + t_I}{2}}\right] - G_I s_{II}(T_I - \theta_I) = F_I\alpha(T_I - \theta_I) + p_I[1115{\cdot}2 - {\cdot}708\theta_{II} - s_{II}(T_I - \theta_I)] - (\Sigma_I + \Sigma_{II} + \Delta_{II}) + \frac{\Sigma y_I(\theta_I - t_I)}{2\left(T_I - \dfrac{\theta_I + t_I}{2}\right)}$$

and by substituting the value of p_I, given by (B_a),* when α is substituted for α_I, rearranging and transposing terms containing G_I to first member of equation:

$$G_I\left(1 - \frac{B_I}{B_x}\right)\left(1115{\cdot}2 - {\cdot}708\theta_{II}\right) - G_I s_{II}(T_I - \theta_I) + G_I s_I(\theta_I - t_I)\left[\frac{T_I - \theta_I}{T_I - \dfrac{\theta_I + t_I}{2}}\right] + G_I s_I(\theta_I - t_I)\left[\frac{T_I - \theta_I}{T_I - \dfrac{\theta_I + t_I}{2}}\right]\frac{1115{\cdot}2 - {\cdot}708\theta_{II} - s_{II}(T_I - \theta_I)}{1115{\cdot}2 - {\cdot}708\theta_I}$$

$$= \left[F_I\alpha(T_I - \theta_I) - \Sigma_I + \frac{\Sigma y_I(\theta_I - t_I)}{2\left(T_I - \dfrac{\theta_I + t_I}{2}\right)}\right]\left[1 + \frac{1}{1115{\cdot}2 - {\cdot}708\theta_I}\left(1115{\cdot}2 - {\cdot}708\theta_{II} - s_{II}(T_I - \theta_I)\right)\right] - (\Sigma_{II} + \Delta_{II})$$

rearranging and solving for G_I:

$$G_I = \frac{\left[F_I\alpha(T_I - \theta_I) - \Sigma_I + \dfrac{\Sigma y_I(\theta_I - t_I)}{2\left(T_I - \dfrac{\theta_I + t_I}{2}\right)}\right]\left[1 + \dfrac{1}{1115{\cdot}2 - {\cdot}708\theta_I}\left(1115{\cdot}2 - {\cdot}708\theta_{II} - s_{II}(T_I - \theta_I)\right)\right] - (\Sigma_{II} + \Delta_{II})}{\left(1 - \dfrac{B_I}{B_x}\right)(1115{\cdot}2 - {\cdot}708\theta_{II}) - s_{II}(T_I - \theta_I) + s_I(\theta_I - t_I)\left[\dfrac{T_I - \theta_I}{T_I - \dfrac{\theta_I + t_I}{2}}\right]\left[1 + \dfrac{1}{1115{\cdot}2 - {\cdot}708\theta_I}\left(1115{\cdot}2 - {\cdot}708_{II} - s_{II}(T_I - \theta_I)\right)\right]}$$

* *Vid.* (B_I).

Now if in place of s_{I} and s_{II}, which represent the specific heat of the solution in first and second bodies, we substitute s to represent the average, or mean, specific heat of the solution in all the bodies, we have approximately, since $\theta_{II} = \theta_{I} - (T_{I} - \theta_{I})$:

$$\left(1 - \frac{B_{I}}{B_{X}}\right)(1115{\cdot}2 - {\cdot}708\theta_{II}) - s(T_{I} - \theta_{I}) = \left(1 - \frac{B_{I}}{B_{X}}\right)(1115{\cdot}2 - {\cdot}708\theta_{I}) - (T_{I} - \theta_{I})\left[s - {\cdot}708\left(1 - \frac{B_{I}}{B_{X}}\right)\right]$$

and hence, if in (D_{a}) this last equivalent is substituted, and the expression $1 + \frac{1}{1115{\cdot}2 - {\cdot}708\theta_{I}}\left[1115{\cdot}2 - {\cdot}708\theta_{II} - s(T_{I} - \theta_{I})\right]$ is represented by J, then formula (D_{a}) becomes:

$$G_{I} = \frac{J\left[F_{I}a(T_{I} - \theta_{I}) - \Sigma_{I} + \dfrac{\Sigma y_{I}(\theta_{I} - t_{I})}{2\left(T_{I} - \dfrac{\theta_{I} + t_{I}}{2}\right)}\right] - (\Sigma_{II} + \Delta_{II})}{\left(1 - \dfrac{B_{I}}{B_{X}}\right)(1115{\cdot}2 - {\cdot}708\theta_{I}) - (T_{I} - \theta_{I})\left[s - {\cdot}708\left(1 - \dfrac{B_{I}}{B_{X}}\right)\right] + J\,s(\theta_{I} - t_{I})\left[\dfrac{T_{I} - \theta_{I}}{T_{I} - \dfrac{\theta_{I} + t_{I}}{2}}\right]} \qquad (D^{D})$$

Formula (D_{D}) gives the value of G_{I} for a double effect, and in a similar manner we may obtain formulæ for calculating G_{I} in the case of a single, triple, and quadruple effect, which would be as follows:—

Single Effect:

$$G_{I} = \frac{F_{I}a(T_{I} - \theta_{I}) - \Sigma_{I} + \dfrac{\Sigma y_{I}(\theta_{I} - t_{I})}{2\left(T_{I} - \dfrac{\theta_{I} + t_{I}}{2}\right)}}{\left(1 - \dfrac{B_{I}}{B_{X}}\right)(1115{\cdot}2 - {\cdot}708\theta_{I}) + s(\theta_{I} - t_{I})\left[\dfrac{T_{I} - \theta_{I}}{T_{I} - \dfrac{\theta_{I} + t_{I}}{2}}\right]} \qquad (D_{S})$$

Triple Effect:

$$G_{I} = \frac{J\left[F_{I}\,a\,(T_{I} - \theta_{I}) - \Sigma_{I} + \dfrac{\Sigma y_{I}(\theta_{I} - t_{I})}{2\left(T_{I} - \dfrac{\theta_{I} + t_{I}}{2}\right)}\right] - (\Sigma_{II} + \Delta_{II})\left[1 + \dfrac{1}{1115{\cdot}2 - {\cdot}708\theta_{II}}\left(1115{\cdot}2 - {\cdot}708\theta_{III} - s(T_{I} - \theta_{I})\right)\right] - (\Sigma_{III} + \Delta_{III})}{\left(1 - \dfrac{B_{I}}{B_{X}}\right)(1115{\cdot}2 - {\cdot}708\theta_{I}) - 2(T_{I} - \theta_{I})\left[s - {\cdot}708\left(1 - \dfrac{B_{I}}{B_{X}}\right)\right] - s(T_{I} - \theta_{I})\left[\dfrac{1115{\cdot}2 - {\cdot}708\theta_{III} - s(T_{I} - \theta_{I})}{1115{\cdot}2 - {\cdot}708\theta_{II}}\right] + Js(\theta_{I} - t_{I})\left[\dfrac{T_{I} - \theta_{I}}{T_{I} - \dfrac{\theta_{I} + t_{I}}{2}}\right]} \qquad (D_{T})$$

in which

$$J = 1 + \left[\frac{1}{1115{\cdot}2 - {\cdot}708\theta_{I}} + \frac{1}{1115{\cdot}2 - {\cdot}708\theta_{II}} - \frac{s(T_{I} - \theta_{I})}{(1115{\cdot}2 - {\cdot}708\theta_{I})(1115{\cdot}2 - {\cdot}708\theta_{II})}\right]\left[1115{\cdot}2 - {\cdot}708_{III} - s(T_{I} - \theta_{I})\right] - \frac{s(T_{I} - \theta_{I})}{1115{\cdot}2 - {\cdot}708\theta_{I}}$$

Quadruple Effect:

$$G_{I} = \frac{\begin{gathered} J\left[F_{I}a(T_{I} - \theta_{I}) - \Sigma_{I} + \dfrac{\Sigma y_{I}(\theta_{I} - t_{I})}{2\left(T_{I} - \dfrac{\theta_{I} + t_{I}}{2}\right)}\right] \\ - (\Sigma_{II} + \Delta_{II})\left[1 + \left(\dfrac{1}{1115{\cdot}2 - {\cdot}708\theta_{II}} + \dfrac{1}{1115{\cdot}2 - {\cdot}708\theta_{III}} + \dfrac{s(T_{I} - \theta_{I})}{(1115{\cdot}2 - {\cdot}708\theta_{II})(1115{\cdot}2 - {\cdot}708\theta_{III})}\right)\left(1115{\cdot}2 - {\cdot}708\theta_{IV} - s(T_{I} - \theta_{I})\right) - \dfrac{s(T_{I} - \theta_{I})}{1115{\cdot}2 - {\cdot}708\theta_{II}}\right] \\ - (\Sigma_{III} + \Delta_{III})\left[1 + \left(\dfrac{1}{1115{\cdot}2 - {\cdot}708\theta_{III}}\right)\left(1115{\cdot}2 - {\cdot}708\theta_{IV} - s(T_{I} - \theta_{I})\right)\right] - (\Sigma_{IV} + \Delta_{IV}) \end{gathered}}{\left(1 - \dfrac{B_{I}}{B_{X}}\right)(1115{\cdot}2 - {\cdot}708\theta_{I}) - 3(T_{I} - \theta_{I})\left[s - {\cdot}708\left(1 - \dfrac{B_{I}}{B_{X}}\right)\right] - 3s(T_{I} - \theta_{I})\left[\dfrac{1115{\cdot}2 - {\cdot}708\theta_{IV} - s(T_{I} - \theta_{I})}{1115{\cdot}2 - {\cdot}708\theta_{II}}\right] + Js(\theta_{I} - t_{I})\left[\dfrac{T_{I} - \theta_{I}}{T_{I} - \dfrac{\theta_{I} + t_{I}}{2}}\right]} \qquad (D_{Q})$$

In the deduction of formula (D), which we will now take up, it will be shown how formulæ (B_{II}) to (C_{IV}) inclusive are obtained.

Formula (D) is deduced as follows:—Since the vapour of evaporation in any body of a multiple effect supplies the steam condensed in the following body, then, for a properly designed apparatus with means provided for carrying off the air and other gases mixed with the vapours evaporated, if Q_{II} represents the quantity of steam which is condensed in evaporating p_{II} quantity of water in the second body, we have, by formula (B_a):

$$Q_{II} = p_I = \frac{F_I a_I(T_I - \theta_I) - G_I s_I(\theta_I - t_I)\left[\dfrac{T_I - \theta_I}{T_I - \dfrac{\theta_I + t_I}{2}}\right] - \Sigma_I + \dfrac{\Sigma y_I(\theta_I - t_I)}{2\left(T_I - \dfrac{\theta_I + t_I}{2}\right)}}{1115{\cdot}2 - {\cdot}708\theta_I} \qquad (B_I)$$

In like manner:

$$Q_{III} = p_{II} = \frac{F_{II}a_{II}(T_{II} - \theta_{II}) + (G_I - p_I)\,s_{II}(\theta_I - \theta_{II}) - \Sigma_{II}{}^*}{1115{\cdot}2 - {\cdot}708\theta_{II}} \qquad (z_{II})$$

and so on, and substituting the above value of Q_{II} in formula (C_a), remembering that $t_{II} = \theta_I > \theta_{II}$, that $\theta_I = T_{II}$, and $(T_I - \theta_I) = (T_{II} - \theta_{II})$, we get:†

$$F_{II} = \left\{ \frac{\dfrac{F_I a_I(T_I - \theta_I) - G_I s_I(\theta_I - t_I)\left[\dfrac{T_I - \theta_I}{T_I - \dfrac{\theta_I + t_I}{2}}\right] - \Sigma_I + \dfrac{\Sigma y_I(\theta_I - t_I)}{2\left(T_I - \dfrac{\theta_I + t_I}{2}\right)}}{(1115{\cdot}2 - {\cdot}708\theta_I)} \times}{\dfrac{1115{\cdot}2 - {\cdot}708T_{II}}{a_{II}(T_{II} - \theta_{II})} - \dfrac{\Delta_{II}}{a_{II}(T_{II} - \theta_{II})}} \right\}$$

From which, if in place of a_I and a_{II} we substitute a:

$$F_{II} = F_I - \frac{G_I s_I(\theta_I - t_I)}{a\left(T_I - \dfrac{\theta_I + t_I}{2}\right)} - \frac{\Sigma_I + \Delta_{II}}{a(T_I - \theta_I)} + \frac{\Sigma y_I(\theta_I - t_I)}{2a\left(T_I - \dfrac{\theta_I + t_I}{2}\right)\left(T_I - \theta_I\right)} \qquad (C_{II})$$

and likewise by formula (CC_a):

$$F_I = \frac{p_I(1115{\cdot}2 - {\cdot}708\theta_I) + G_I s_I(\theta_I - t_I)\left[\dfrac{T_I - \theta_I}{T_I - \dfrac{\theta_I + t_I}{2}}\right] + \Sigma_I - \dfrac{\Sigma y_I(\theta_I - t_I)}{2\left(T_I - \dfrac{\theta_I + t_I}{2}\right)}}{a(T_I - \theta_I)} \qquad (C_I)$$

Substituting the value of F_{II}, given by (C_{II}), in value for p_{II}, given by (z_{II}), or as found by formula (B_a) when $\theta_x < t_x$, substituting a for a_{II}, and remembering that $(T_I - \theta_I) = (T_{II} - \theta_{II})$, we get:

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* This is a case of $\theta_x < t_x$. *Vid.* formula (B_c).

G_x for any body of the apparatus equals the original quantity of solution minus the total evaporation in the preceding bodies, and the temperature of the solution entering any body is the temperature of boiling in preceding body.

† When $\theta_{II} < t_{II}$ ($= \theta_I$) formula (C_a) gives $F_{II} = \dfrac{Q_{II}(1115{\cdot}2 - {\cdot}708T_{II}) - \Delta_{II}}{a_{II}(T_{II} - \theta_{II})}$. *Vid.* formula ($A_b$).

in which

$$J = 1 + \Big[\frac{1}{1115{\cdot}2 - {\cdot}708\theta_{I}} + \frac{1}{1115{\cdot}2 - {\cdot}708\theta_{II}} - \frac{s(T_{I} - \theta_{I})}{(1115{\cdot}2 - {\cdot}708\theta_{I})\,(1115{\cdot}2 - 708\theta_{II})} + \frac{1}{1115{\cdot}2 - {\cdot}708\theta_{III}} - \frac{3s(T_{I} - \theta_{I})}{(1115{\cdot}2 - {\cdot}708\theta_{I})(1115{\cdot}2 - {\cdot}708\theta_{III})} - \frac{s(T_{I} - \theta_{I})}{(1115{\cdot}2 - {\cdot}708\theta_{II})(1115{\cdot}2 - {\cdot}708\theta_{III})}\Big]$$

$$\Big[1115{\cdot}2 - {\cdot}708\theta_{IV} - s(T_{I} - \theta_{I})\Big] - 3_{I}\frac{s(T_{I} - \theta_{I})}{1115{\cdot}2 - {\cdot}708\theta_{I}}$$

By inspection of formulæ (D_s), (D_T), and (D_Q), it will be seen that an approximate general formula for G_I, that is, the quantity of original sugar solution, or one whose vapour is water, entering the first body of a multiple effect of N number of bodies, up to and including a quadruple, is that given by formula (D), in which

$$J = 1 + E_N\Big[1115{\cdot}2 - {\cdot}708\theta_N - s(T_I - \theta_I)\Big] - \frac{(N-1)\,(N-2)}{2}\;\frac{s(T_I - \theta_I)}{1115{\cdot}2 - {\cdot}708\theta_I}$$

The exact values of E_N have already been given, but for ordinary working conditions of heating steam of about $5\frac{1}{3}$ lbs. pressure which has a temperature of 228° F., and temperature of boiling in last body of any multiple effect 140° F., the value of E_N may be approximately found by the formula:

$$E_N = (N - 1)\,({\cdot}00105 - {\cdot}000017N)$$

In the foregoing deduction of formula (D) it has been shown how formulæ (B_{II}) and (C_{II}) are obtained, and formulæ (B_{III}), (B_{IV}), (C_{III}), and (C_{IV}) may be deduced in similar manner.

For convenience of reference, and to show the similarity of Jelinek's formulæ and those we have deduced, the latter formulæ, as modified when $\theta_x = t_x$ and $\theta_x < t_x$, and substituting a for a_x, are now given:—

When $\theta_x = t_x$, formulæ (A_a), (AA_a), (B_a), and (C_a) become, respectively:

$$Q_x = \frac{F_x a(T_x - \theta_x) + \Delta_x}{1115{\cdot}2 - {\cdot}708T_x} \qquad (A_b)$$

[Same as Jelinek's formula, (b), when $\Delta_x = 0$.]

$$Q_x = \frac{p_x(1115{\cdot}2 - {\cdot}708\theta_x) + \Delta z_x + \Sigma z_x}{1115{\cdot}2 - {\cdot}708T_x} \qquad (AA_b)$$

[In this case Δz_x and $\Sigma z_x = \Delta_x$ and Σ_x, respectively.]

$$p_x = \frac{F_x a(T_x - \theta_x) - \Sigma_x}{1115{\cdot}2 - {\cdot}708\theta_x} \qquad (B_b)$$

[Same as Jelinek's formula, (d), when $\Sigma_x = 0$.]

$$F_x = \frac{Q_x(1115{\cdot}2 - {\cdot}708T_x) - \Delta_x}{a(T_x - \theta_x)} \qquad (C_b)$$

[From (A_b).]

and when $\theta_x < t_x$:

$$Q_x = \frac{F_x a(T_x - \theta_x) + \Delta_x}{1115{\cdot}2 - {\cdot}708T_x} \qquad (A_c)$$

[Same as Jelinek's formula, (b), when $\Delta_x = 0$.]

$$Q_x = \frac{p_x(1115{\cdot}2 - {\cdot}708\theta_x) - G_x s_x(t_x - \theta_x) + \Delta z_x + \Sigma z_x}{1115{\cdot}2 - {\cdot}708T_x} \qquad (AA_c)$$

[In this case Δz_x and $\Sigma z_x = \Delta_x$ and Σ_x respectively.]

$$p_x = \frac{F_x\alpha(T_x - \theta_x) + G_x s_x(t_x - \theta_x) - \Sigma_x}{1115{\cdot}2 - {\cdot}708\theta_x} \qquad (B_c)$$

$$F_x = \frac{Q_x(1115{\cdot}2 - {\cdot}708T_x) - \Delta_x}{\alpha(T_x - \theta_x)} \qquad (C_c)$$

[From (A_c).]

To which may be added the special case, when $\theta_x < t_x$, and in addition $G_x = p_x$ and $s_x = 1$, loss of heat being neglected:

$$Q_x = \frac{F_x\alpha(T_x - \theta_x)}{1115{\cdot}2 - {\cdot}708T_x} \qquad (b)$$

[Jelinek's formula (b).]

$$p_x = \frac{F_x\alpha(T_x - \theta_x)}{1081{\cdot}4 + {\cdot}305\theta_x - t_x} \qquad (d)$$

[Jelinek's formula (d).]

If we now apply formulæ (D), (B_a), (B_{II}), (AA_a), and (C_{II}) to the calculations of the double effect before considered, neglecting all losses of heat, we may compare the results obtained by these formulæ with the results obtained by Jelinek's and Déon's formulæ.

Substituting the proper values in formula (D) we get:

$$G_I = \frac{J \times 2000 \times 4 \times 44}{\left(1 - \frac{12}{54{\cdot}3}\right)(1115{\cdot}2 - {\cdot}708 \times 184) - 44\left[1 - {\cdot}708\left(1 - \frac{12}{54{\cdot}3}\right)\right] + 24{\cdot}52J}$$

$$= \frac{352000J}{747{\cdot}526 + 24{\cdot}524J}$$

but

$$J = 1 + \frac{1}{1115{\cdot}2 - {\cdot}708 \times 184}(1115{\cdot}2 - {\cdot}708 \times 140 - 44) = 1{\cdot}9869$$

hence

$$G_I = -\frac{352000 \times 1{\cdot}9869}{747{\cdot}526 + 24{\cdot}524 \times 1{\cdot}9869} = 878{\cdot}35$$

Substituting this value of G_I in formula (B_a), or (B_I), and (B_{II}), respectively:

$$p_I = \frac{2000 \times 4 \times 44 - 878{\cdot}35 \times (184 - 150)\left[\dfrac{44}{228 - \dfrac{184 + 150}{2}}\right]}{1115{\cdot}2 - {\cdot}708 \times 184} = 335{\cdot}51$$

$$p_{II} = \frac{2000 \times 4 \times 44 - 878{\cdot}35 \times (184 - 150)\left[\dfrac{44}{228 - \dfrac{184 + 150}{2}}\right] + (878{\cdot}35 - 335{\cdot}51) \times 44}{1115{\cdot}2 - {\cdot}708 \times 140}$$

$$= 348{\cdot}73.$$

Substituting the above values in formulæ (AA_a) and (C_{II}), respectively:

$$Q_{I} = \frac{335 \cdot 51 (1115 \cdot 2 - \cdot 708 \times 184) + 878 \cdot 35 \times (184 - 150)}{1115 \cdot 2 - \cdot 708 \times 228} = 377 \cdot 78$$

$$F_{II} = 2000 - \frac{878 \cdot 35 \times (184 - 150)}{4 \times \left[228 - \frac{184 + 150}{2}\right]} = 1877 \cdot 61$$

The results of calculation obtained by using these latter formulæ, tabulated with the results previously obtained by using formulæ according to Jelinek's and Déon's deductions, are then as follows:—

Calculations for a Double Effect. Steam, 5½ lbs. Juice, 150° F. Vac. cor. to 149° F.	According to formulæ— Jelinek.	Déon.	Eastwick
Heating surface of first body, sq. ft.	2000·00	2000·00	2000·00
,, ,, second ,, ,,	1932·14	1958·62	1877·61
Total solution concentrated, lbs. per min.	892·15	898·06	878·35
Water evaporated in first body, lbs. per min.	345·26	334·90	335·51
Water evaporated in second body, lbs. per min.	349·81	364·78	348·73
Steam required to operate apparatus, lbs. per min.	369·06	352·37	377·78

An inspection of this table shows how the results differ according to the formulæ used. It would seem that both Jelinek's and Déon's formulæ give the efficiency much too large, and this, doubtless, accounts, in great part, for the marked discrepancy in the practical and accepted theoretical capacities of multiple effects.

In making the foregoing calculations α has been assumed to have a value of 4, which, it has been stated, is the average for an ordinary standard vertical multiple effect when clean, which some may contend is too low. It is claimed that the value of α for a Wellner-Jelinek type of apparatus is over 4·5, and for some of the more modern apparatus, in which there is an increased velocity of circulation of liquid, this value becomes much greater.

Transmission of heat through metal from steam to a liquid is a subject, which, at the present time, is not thoroughly understood, and no generally accepted formulæ have yet been offered for accurately calculating the coefficient of heat transmission. Numerous experiments have been made showing that when a liquid is heated by steam, as accomplished in the single or multiple effect, the value of α depends upon certain conditions:—

First, material and thickness of the tubes;
Second, liquid being heated, its concentration and viscosity;
Third, depth of liquid being heated;
Fourth, velocity of flow of liquid being heated, or circulation.

It is claimed, moreover, by some* that the amount of heat transmitted is greater when steam is on the outside of a tube than when on the inside, and also that horizontal tubes transmit more heat, per sq, ft. of surface, than vertical tubes.†

The amount of heat transmitted, per degree mean difference in temperature between heating steam and liquid being heated, has generally been assumed to be independent of temperature of fluids, but the more recent experiments indicate that this is not correct, and that the transmission of heat increases with the increase in mean difference of temperature, and the temperature of the heating steam.‡

The experiments of Youle and Ser seem to lead to the conclusion that a increases with the cube root of the velocity of liquid, and E. Hausbrand has given from his experience a formula for a, which, converted into English Measure, would read:—

$$a = 2{\cdot}56 \sqrt[3]{0{\cdot}007 + {\cdot}3048v} \text{§}$$

in which

a = Heat transmitted per sq. ft. per minute per degree Fahr., B.T.U.,

v = Velocity of liquid, feet, per second.

Konstantin Schwartz offers the following formula, in which the same letters stand for the similar quantities:—

$$a = 3{\cdot}85 \sqrt[3]{0{\cdot}84 + {\cdot}5425v} \,\|$$

It is evident from the above that there is yet much to be learned regarding the laws of transmission of heat. and that no accurate calculations can be made of the coefficient of heat transmission for the tubes of a single or multiple effect by any formulæ which have so far been presented; the same is also more or less true regarding the losses of heat from an apparatus, though on this subject there is probably more accurate data available.

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* Kopp and Meyster, Stevens Indicator, January, 1894.

† Prof. F. R. Husa states that the transmission of heat is in the proportion of 22 to 16.

‡ The experiments of Jelinek and the more recent ones of H. Claassen (1893) show the effect of density of solution and temperature in modifying the coefficient of heat transmission.

Jelinek found that in a horizontal apparatus the values of a_x, expressed in English Measure, were:

	Bodies. 1st.	2nd.	3rd.	4th.
Double Effect	4·5	3·5	—	—
Triple "	7·6	5·1	2·9	—
Quad. "	5·7	5·3	4·1	1·2

While Claassen found these values for a vertical apparatus to be:

	Bodies. 1st.	2nd.	3rd	4th.
Triple Effect	8·2-10·2	6·1-7·1	2·5-3·1	—
Quad. "	8·2-10·2	6·1-8·2	4·1-6·1	2·1-3·1

§ *Beet Sugar Gazette*, 1903.

‖ The formula in Metric System, as given, is $a = 18{\cdot}8 \sqrt[3]{0{\cdot}84 - 1{\cdot}78v}$, expressed in calories, metres, and Centigrade.

In conclusion it might be well to refer once more to the often discussed question of the relative areas of heating surfaces required for a multiple effect, regarding which there is still great difference in opinion.

Referring to formulæ (C_{II}), (C_{III}), and (C_{IV}), it at once becomes evident at a glance that if our deductions have been correct, then the heating of each body should be increased from the first to the last, except in the case of the second body. It will be seen that formula (C_{II}) gives a value for F_{II} greater than F_I only when the value of θ_I is less than t_I, or, in other words, when the temperature of the solution entering the first body is greater than the temperature of boiling in that body; if these temperatures are equal, the values of F_{II} and F_I become practically equal, since the loss of heat is comparatively small, and in all cases where the temperature of the solution entering the first body is less than the temperature of boiling in that body, which is usually the case, the value of F_{II} becomes smaller than F_I.

It would, therefore, seem better practice to make the heating surface of the first and second body of a multiple effect of about equal areas, and to increase the succeeding bodies proportionately as determined by the formulæ.

Rillieux, the inventor of the multiple evaporator, believed that the heat surfaces of the succeeding bodies should be increased, and, despite numerous arguments and calculations which have been offered to prove the contrary correct, he was apparently in the right. Aside from mathematical calculations, this conclusion would seem to be logical, when we consider the fact that in each body there is an increase in the amount of evaporation over that of the preceding body, due to the decrease in temperature of boiling, and on account of which the liquid entering at a higher temperature is, in part, evaporated by its own heat, more than off-setting the decrease in evaporation by transmitted heat of vapour, resulting from increase in the latent heat, and losses of heat; moreover, while in some of our formulæ* we have not considered change in value of the coefficient of heat transmission, it is true that the value of this coefficient decreases in each succeeding body, which would tend to further increase the required area of heating surface.

Mr. Havemeyer recently offered a silver loving cup as a prize for the best sugar beets raised under irrigation in the United States. The winning beets were grown by a Mr. Rhodes, of Garland, in a clay loam soil. No fertilizer was used. They gained 93 points out of a possible 100.

* These formulæ are (C_{II}), (C_{III}), (C_{IV}), and (D) only, and in them a mean value for coefficient of heat transmission has been substituted for exact values, which does not materially modify the result.

THE DETERIORATION OF CUT SUGAR CANE.

By J. Weinberg.

In the sugar cane literature numerous remarks are to be found upon the quick deterioration of cut cane, but all recorded experiments, however carefully conducted, seem to lack the most important basis, *viz.*, the certainty of a uniform material to experiment on.

Most of the experiments were made by keeping 5-6 cartloads or bundles of cane and grinding one cartload every day, the analyses of the juice being the criterion by which to judge the deterioration. There was, however, no guarantee whatever that the different cartloads or bundles had the same sucrose contents to start with; and anybody, who has experienced the difficulty in sampling cane, knows that it is very improbable that this was the case.

The first, to my knowledge, to experiment on a rational basis was Mr. M. van Czerniecki of Tjomal (Java), who in the *Java Sugar Archief*, 1900, page 606, describes his experiments. The material was prepared by halving a certain number of canes grown close to each other and methodically composing samples of the halves. Although he himself complains about the samples not being *absolutely* uniform, the results are very reliable as a large number of canes were employed.

One of his experiments gave the following results:—

Days kept	0	1	2	3	4	5
Available percentage of sugar in canes	16·2	16·0	13·5	11·6	10·8	9·9

in other words, after having kept the cut cane for five days about 38 per cent. of the available sugar or more than one-third had disappeared.

Copying the example set by van Czerniecki in carefully preparing the samples so as to ensure a uniform material, the writer made the experiments here described, part in Java in the hot season, part in India in the United Provinces of Agra and Oudh in the cold season. It will be seen from the results that the differences in temperature and humidity did not make any noticeable difference in the deterioration, although we might *à priori* have expected the reverse to be the case.

At the outset it is necessary to explain the following expressions and signs which will be used.

Degrees Brix (°Bx.) is the density of the juice expressed in degrees of Brix's scale at (or calculated to) a temperature of 17½° Centigrade (= 63·5° F.). If the juice were a pure sucrose solution, the degrees Brix would indicate the percentage by weight of sucrose in the solution, and although not quite correct it is agreed to consider the degrees Brix of a cane juice as the percentage by the weight of soluble solids in it. The degrees Brix represent in reality the figure given by Dr. Leather, as "Total Sugar calculated from density." (*Agricultural Ledger*, No. III, 1897, pages 18-19.)

Percentage Sugar (% S.) expresses the result of the polariscopical reading of cane juice through a 200 mm. tube (Normal weight 26·048 grammes). Accurately speaking, it is not the Percentage Sucrose in the juice owing to the lævorotation of the Invert-sugar, but it can be, and indeed is *in practice*, without great fault, taken as such where cane juices are concerned. When absolutely correct results are derived, the cane juice is inverted and the percentage sucrose is calculated by means of "Clerget's Formula." This method is followed by Dr. Leather in his "Analysis of Sugar Cane," but as the formula for the Available Sugar used in his paper has reference to the simple Polarisation, Clerget's Formula has not been used.

Quotient of Purity (Q. P.) is expressed by the following formula:—

$$\text{Q. P.} = \frac{\%\,{}^\circ\text{S.}}{{}^\circ\text{Bx.}} \times 100$$

in other words, it indicates what percentage of the (apparent) soluble solids is the sucrose, and gives a very good indication of the quality of the juice.

The final results of the following experiments are expressed in *Parts of available sugar per 100 cane* (% Av. Sg.) according to the following—absolutely empirical—formula:—

$$\%\ \text{Av. Sg. (cane)} = \%\ \text{S. (in juice)} \times 0{\cdot}85 \times 0{\cdot}90 \times \frac{\text{Q.P.}-2}{100}$$

of which formula the following explanation may be given.

Between the % sugar in cane containing about 10-12 per cent. fibre and the % sugar expressed from the cane by single crushing there exists a certain proportion which on the average can be taken as 0·85. If therefore the juice contains "S" % sugar, the cane contains

$$\text{S.} \times 0{\cdot}85\ \%\ \text{sugar.}$$

If we now wish to calculate the available sugar for triple crushing, we may expect to obtain 90 per cent. of the sugar in the cane expressed by the mills in the juice, so that % *sugar expressed in juice per 100 parts of cane is:*—

$$\text{S.} \times 0{\cdot}85 \times 0{\cdot}90 = \text{S.} \times 0{\cdot}765.$$

This sugar, however, is not all available as finished sugar. Part of it goes to the inevitable losses, and part of it remains in the molasses, and it is obvious the higher the Q.P. is the more of the sugar is finally available.

If—and we will in this case suppose this—we are dealing with a factory turning out white sugar, we can, without great mistake, take the available sugar of a juice of the following composition: % Sugar "L" and Quotient of Purity "R" as

$\%\ \text{Av. Sg. (juice)} = \text{L} \times \frac{\text{R}}{100}$, and continuing our formula we would find that:

$$\%\ \text{Av. Sg. per 100 cane} = \text{S.} \times 0{\cdot}765 \times \frac{\text{Q.P.}}{100}.$$

The juice we deal with for these experiments is, as already mentioned, expressed by single crushing, and as experience has taught that juice expressed by triple crushing and maceration has a purity which on an average is "2" lower than that of the first mills juice, our formula is reduced to the following equation :—

$$\% \text{ Av. Sg.} = \text{S.} \times 0{\cdot}765 \times \frac{\text{Q.P.}-2}{100}.$$

Although now-a-days the above-mentioned formula is becoming superseded by newer and more correct formulas (Dr. Winter), it would, however, not be within the scope of this paper to explain them, and for our use the above-mentioned formula is more than sufficient.

It is further understood in the following that the deterioration is due to inversion of sucrose, and that the increase in density of the juice is entirely due to evaporation, so that to obtain the % Av. Sg. of the cane the juice is calculated back to the original density. For example :—

Let the 1 day's juice have .. 18·0 Bx. 90 Q.P. 16·2 % and
,, 4 ,, ,, ,, .. 18·8 ,, 86 ,, 16·17 % ,,

Let then the composition of the fourth day's juice be taken for the purpose of calculating the % Av. Sg. as

18·0 Bx., 86·0 Q.P. and $(18{\cdot}0 \times 0{\cdot}86) = 15{\cdot}4$ % S.

It is easily understood that this method of calculating—although not scientifically proved—is justifiably used, as through evaporation the juice, and with it the cane, apparently sometimes gains in sugar contents, which of course cannot be the case with the Available Sugar as the evaporation only means that the cane contains a lower percentage of juice.

A more correct way would have been to estimate the percentage of fibre in the samples every day, and the writer regrets not having had time or occasion to estimate the fibre and the invert-sugar in the samples as both these figures would have made the experiments more complete.

The first experiment made was to ascertain whether the method followed would ensure a homogeneous material.

Thirty-six canes were laid out side by side, top and root ends were cut off and the canes were cut up each into four pieces A, B, C, D.

The 144 pieces were divided into four samples by taking the pieces diagonally, so that

Sample I. consisted of A_1, B_2, C_3, D_4, A_5, &c.
,, II. ,, ,, B_1, C_2, D_3, A_4, B_5, ,,

&c., &c.

Each sample consisted of 36 pieces or the equivalent of nine canes.

The samples were crushed in a small three-roller mill and the juices analysed separately. The results were :—

No.	Juice.			Cane.
	° Brix.	Percentage Sugar.	Q. Purity.	Percentage Available Sugar.
I.	18·2	16·30	89·6	10·9
II.	18·2	16·20	89·0	10·8
III.	18·3	16·30	89·1	10·9
IV.	18·1	16·14	89·2	10·8

The above results show that the method gave samples which, for the purpose in question, were sufficiently uniform.

A second experiment was made for the purpose of ascertaining whether the more cut surfaces per cane, which this method of sample-taking necessitated, had any noteworthy influence upon the deterioration.

For this purpose 56 canes were divided in the above-mentioned manner into four samples, each consisting of 56 pieces or the equivalent of 14 canes. In two of the samples all the pieces were subdivided into three smaller pieces, so that I now had two and two samples alike :—

Two having 8 cut surfaces per cane
,, ,, 24 ,, ,,

The samples were put aside for 90 hours and then analysed. The results were :—

Number cut surfaces per cane.	° Brix.	Percentage Sugar.	Q. Purity.
24	19·6	16·71	85·3
24	19·4	16·63	85·7
Average	19·5	16·67	85·5
8	19·2	16·29	84·9
8	19·3	16·61	86·1
Average..	19·25	16·45	85·5

The quality of the juices was the same, but owing to the larger cut surface the juice of the one sample had evaporated more and the °Brix had increased accordingly. However, recalculating both samples to 19·25° Brix we find that the % Av. Sg. per 100 cane was the same for both samples, *i.e.*, 10·5 per cent., and this shows that increasing the cut surface does not apparently increase the rate of deterioration.

The following experiments were all made in order to determine deterioration of the sugar content of the cane. The sampling was

carried out as described, care being taken to get the original material as homogenous as possible. The results of the analyses are given below. The last column in the tables gives the available sugar in per cent. of the Av. Sg. in the original sample. For example, if fresh cane contained 11 % Av. Sg. and the same cane after four days only contained 8·8 per cent., this would be indicated in the lost column by the figure "80 per cent."

I.—Experiment conducted at Pakkies, Java. Cane: White Manilla. 11 months old, sixty canes cut the same day and made into six samples, each equivalent to 10 canes.

Days cut.	°Brix.	Percentage Sugar.	Q. Purity.	Recalculated upon Original Density.		
				Percentage S. Juice.	Percentage Av. Sg. Cane.	Av. Sg. pr.100 Av. Sg. Original Sample.
0	19·4	17·73	91·4	17·73	12·4	100
1	19·7	17·83	96·6	17·58	12·2	98·4
2	20·0	17·50	87·5	16·98	11·4	91·9
3	20·1	16·20	80·6	15·64	9·7	78·2
4	20·4	15·03	73·7	14·30	8·1	65·3
5	20·5	14·56	71·0	13·77	7·6	61·3

II.—Experiment conducted at Pakkies, Java. Cane: Purple Cheribon. 11½ months old, sixty canes cut same day and made into six samples, each equivalent to 10 canes.

0	18·0	16·01	88·9	16·01	10·7	100
1	18·2	16·22	89·1	16·04	10·7	100
2	18·4	16·04	87·2	15·70	10·5	98·1
3	19·0	16·05	84·5	15·20	9·8	91·6
4	19·3	14·98	77·6	13·97	8·3	77·6
5	19·6	14·70	75·0	13·50	7·8	72·9

III.—Experiment conducted at Pakkies, Java. Cane: Manilla. 10½ months old, ninety canes cut same day and made into six samples, each equivalent to 15 canes.

0	19·7	18·27	92·7	18·27	12·7	100
1	20·1	18·50	92·0	18·13	12·5	98·4
2	20·2	18·37	90·9	17·91	12·2	96·1
3	20·8	17·88	86·0	16·94	10·9	85·8
4	21·0	15·87	75·6	14·90	8·4	66·1
5	21·8	15·28	70·1	13·81	7·2	56·7

IV.—Experiment conducted at Rosa, U.P. Cane: Dikchan. 11 months old, sixty canes cut same day and made into five samples, each equivalent to 12 canes.

0	18·4	14·93	81·1	14·93	9·0	100
1	18·8	14·90	79·3	14·59	8·6	95·6
2	19·2	14·90	77·6	14·28	8·3	92·2
3	19·7	14·34	72·8	13·40	7·3	81·1
4	20·0	13·86	69·3	12·75	6·6	73·3

V.—Experiment conducted at Rosa, U. P. Cane: Rukhra. Age, unknown. Five samples, each equivalent to 15 canes cut two days before samples prepared.

Days cut.	° Brix.	Percentage Sugar.	Q. Purity.	Recalculated upon Original Density.		
				Percentage S. Juice.	Percentage Av. Sg. Cane.	Av. Sg. pr. 100 Av. Sg. Original Sample.
0	20·0	17·10	85·5	17·10	10·9	....
1	21·3	17·09	80·0	16·00	9·8	....
2	21·8	15·49	71·1	14·22	7·5	....
3	22·0	13·02	59·2	11·84	5·2	....
4	22·2	11·26	50·7	10·14	3·9	....

The last experiment was carried out with cane, which, when the samples were prepared, already had been cut for about 48 hours, a fact which the deterioration figures clearly show.

Summary.

Taking an average of all the experiments (except the last), we find the following figures :—

Days cut.	0	1	2	3	4
Av. Sg. per 100 .. .. Av. Sg. original sample	100 ..	97·3 ..	92·0 ..	78·6 ..	67·9
Total loss Av. Sg. ..	0·0 ..	8·0 ..	8·0 ..	21·4 ..	32·1
Daily loss Av. Sg.	0·0 ..	2·7 ..	5·3 ..	13·4 ..	10·7

In practice the cane is, or should be, received at the factory at the latest 24—36 hours after cutting, so that great care must be taken not to have more cane in stock than can be worked off by the mills or diffusion battery in 24 hours. It must be borne in mind that in the case of a cane which when fresh cut gives 10 per cent. out-turn and costs 6 annas per maund, a difference of 20 per cent. Av. Sg. means a difference in cost price of the produced sugar of Re. 0-15-0 (Rs. 4-11-0

in the place of Rs. 3-12-0) without counting the increased expense of manufacturing from such deteriorated cane. It is true that some of the loss is compensated by the greater amount of molasses obtained, but after all the *raison d'être* of a sugar factory is to make "sugar," and the spirit that can be made is a question of secondary importance. An easy calculation will show anybody interested that with the present prices of sugar and spirit sucrose is considerably more valuable in its proper form than when inverted into a material for the fermenting house.

Of course, the facts demonstrated by these experiments are not new to the sugar manufacturer. Experience has already taught him, at his own expense, that he gets a larger yield of sugar from fresh cane than from stale; it is, however, very doubtful whether he knows that even the gain of 24 hours at the right moment would give him a considerably sweeter sugar.

As Dr. Leather rightly remarks, it matters but little to the native *gur*-manufacturer whether his juice contains more or less invert sugar (within certain limits), but for the European sugar manufacturer in India it is quite another question. He has to deliver his product as a high-classed crystallised sugar, and every small increase of invert sugar means a large loss to him.

India's cane sugar industry under European supervision is yet a young and, let it be hoped, rising industry. It is very doubtful if, with a few exceptions, it can grow its own sugar cane, in which case the controlling of the cutting of the cane would be comparatively simple. Probably the cane will be bought from the native, to whom it is of doubtful interest to bring it fresh to the factory. As a fact it is much easier for him to cut the cane in odd minutes and to delay bringing it to the factory until he has accumulated enough cane to fill one or two carts.

The Indian sugar manufacturer has not got the excellent expedient for controlling the quality of the cane which his Continental colleague has, *viz.*, the taking of a sample out of each cart and the analysing of it. Both the sample-taking and the analysing methods would present large practical difficulties, so that the only remedy left to him is to have one or two active employees, well acquainted with the local customs and language, who are on a constant look-out at the villages and cane fields, and urge the "ryot" eventually, through the promise of a premium, to bring his cane in immediately it is cut.

To economise money by doing without this kind of supervision and system of premiums would be to allow thousands and thousands of rupees to be lost through inversion, and could only be termed *une économie de bouts de chandelles.*—*(Agricultural Ledger.)*

GERMANY.

Results of the Campaign of 1902-03.

The number of factories at work during the season which closed on 31st July last was 390, against 397, 395, and 399 in the preceding seasons.

The quantity of beets worked up amounted to 11,255,958 metric tons, against 16,012,866 metric tons in 1901-02, and 13,253,908 in 1900-01.

The sugar production in raw sugar value, including the sugar extracted from molasses, was:—

1902-03. Metric Tons.		1901-02. Metric Tons.		1900-01. Metric Tons.
1,628,810	..	2,182,360	..	1,874,716

The yield obtained was 14·47 per cent., against 13·63 per cent. in 1901-02, 14·14 in 1900-01, and 13·58 in 1899-1900.

The exports in raw sugar equivalent were:—

1902-03. Metric Tons.		1901-02. Metric Tons.		1900-01. Metric Tons.
1,010,659	..	1,216,486	..	1,144,250

The inland consumption in raw sugar equivalent amounted to:—

1902-03. Metric Tons.		1901-02. Metric Tons.		1900-01. Metric Tons.
786,694	..	743,520	..	767,575

CONSULAR REPORTS.

Japan.

Nagasaki.—The trade in sugar is of great importance to British interests, forming, as it has done for many years, about 95 per cent. of the total value of the imports to Japan from Hong-Kong. The import into Nagasaki in 1902 amounted to 78,177 cwts. valued at £44,599. These figures show a decrease from the import of 1901 of 254,878 cwts. and of £183,103 in value.

The import into Nagasaki in 1902 was classified in the customs return as follows:—

Brown sugar.—This includes not only raw and brown sugar strictly so called, but also all qualities of partially refined sugar up to and including refined sugar of No. 14 Dutch Standard in colour. Class I.—(*a*) up to No. 7, inclusive, Dutch Standard of colour, 26,386 cwts., of the value of £10,526; (*b*) up to No. 14, inclusive, Dutch Standard, 13,234 cwts., of the value of £6,492. Class II.—(*a*) up to No. 20, inclusive, Dutch Standard, 3,636 cwts., of the value of

£2,450; (b) above No. 20, Dutch Standard, 34,921 cwts., of the value of £27,581.

The increase in the import during 1901 was attributable, as remarked in last year's report, to the attempt to evade payment of the consumption tax which came into operation on October 1st, 1901. This tax is collected, as regards imported refined sugars, before they are removed from the customs. It is true that the regulations allow of their being stored in bond, but the charges for storage in the bonded warehouses are too heavy to make this course practicable, and these warehouses, too, are unwilling to store large quantities.

The great decline noticeable in the amount of sugar imported during 1902 is due in part to this anticipatory import of 1901, in part also to the increasingly keen competition of the native refineries in Japan and Corea, which will, there is little doubt, gradually supply more and more of the refined sugar required in Japan.

Of Class I., £7,191 came from China, £7,276 from the Philippines, £1,230 from Hong-Kong, and smaller quantities from the Dutch, British and French colonies. Of Class II., the import from Hong-Kong amounted to £20,700, and the balance, under £7,000, from Germany. The total value of sugar imported into Nagasaki from Hong-Kong in 1901 was £171,298.

North Formosa.—There is a notable falling off in the value of the sugar import. It has decreased from £41,408 to £9,390, all of the latter refined sugar, as against £3,000 worth of the last in 1901.

Shimonoseki.—The decrease of £190,000 in the import of sugar was anticipated in last year's report, when it was pointed out that the import for 1901 was abnormally large in order to evade the inland revenue tax imposed on all stocks not cleared from the customs by October 1st of that year, and the heavy stocks then imported were found to be more than sufficient to meet the demand. Prices advanced towards the close of last year for new supplies as old stocks had been got rid of by that time, and the demand in America for Java raw sugar had raised the price of raw material.

The figures for the sugar imported during the last three years are:—

Year.	Quantity. Tons.	Value. £
1902	8,250	114,376
1901	21,511	304,549
1900	11,397	167,251

Of the total import of "A" quality in 1902, over £20,000 was cane sugar; whilst of the "B" quality, £49,300 represents roughly the value of the cane and £44,000 that of the beet sugar imported.

Of the latter, £26,500 worth came from Austria-Hungary and £17,500 from Germany, a small quantity was also imported from Java and the Philippine Isles.

"A" quality represents 15 to 20, and "B" quality above 20 Dutch standard; the tendency is towards the better grades, and the import of sugar below 15 has practically ceased.

Madeira.

The British Consul reports as follows: –

Owing to the drought in 1900 and the heavy rains in 1901, the cane crop was a very short one in the latter year, and the cane itself was of a very inferior quality. The entire crop of the island was roughly estimated at 25,000 tons, valued at £67,000, of which 8,000 tons were turned into sugar and the remainder into cane spirit for local consumption.

The crushing season began a month later than usual, and nearly all the different qualities of cane were attacked by a disease of a fungoid nature; the only exception being the Yuba, or Uba, cane, which was imported here from Natal. This cane is, I understand, of Chinese origin. It is very thin, but contains a far larger amount of sugar than any other species known in Madeira. It has also the peculiarity of pushing its roots to a much greater depth, and the wind has little or no effect upon it. It sends up innumerable shoots, and in good ground 80 to 120 canes from a single "stolon" are obtained.

Analysis of Yuba Cane (by Messrs. W. Hinton & Son, Madeira).

	Per centage.
Density	8·25
Sugar	20·50
Glucose	0·05
"Brix"	22·14
Purity	93·0
Quotient of glucose	0·24
Beaumé	11·2

The entire cane crop of the island last year was roughly estimated at 21,000 tons, valued at £57,000, of which amount 6,000 tons were converted into sugar and the remainder into cane spirit for local consumption. The cane crop, when ripe, was attacked by a gummy fungoid disease, which, at the end of the season, made it impossible to manufacture sugar. Some of the new seedling canes, such as B 208 and B 147, were imported from Barbados with the view of changing the species in the island. The Yuba cane has, up to the present, resisted the disease.

All the cane turned into sugar was manufactured by Naudet's diffusion process, and the results obtained surpassed the manufacturer's expectations.

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. Thompson, C.E., F.C.S., M.I.M.E. Chartered Patent Agent, 6, Lord Street, Liverpool; and 322, High Holborn, London.

ENGLISH.—Applications.

19962. F. Meyer, London. (Communicated by John William Meyer and James Wardrop Arbuckle, Trinidad.) *An improved means of evaporation for the concentration or condensation of saccharine syrups, brine or other fluid.* Complete specification, 16th September, 1903.

19993. W. Greiner, Liverpool. *Improvements in evaporating and boiling down apparatus.* 16th September, 1903.

20585. A. J. Liversedge, London. *Improvements in the manufacture of cube and tablet sugar.* 25th September, 1903.

21485. J. J. Marshall, London. *Improvements in the method of and in apparatus for weighing granulated sugar and the like.* 6th October, 1903.

21502. G. S. Baker, London. *Improvements in grinding machines especially adapted for chocolate and the like.* 6th October, 1903.

21524. R. A. Naylor, Warrington. *Machine for making bars or tablets of sweets.* 7th October, 1903.

ABRIDGMENTS.

6694. H. A. Peterson, Honolulu, United States of America. *Improvements in centrifugal extracting machines.* Date under International Convention, 24th March, 1902. This centrifugal extracting machine comprises a revoluble main vessel having a perforated vertical wall, a second vessel arranged concentrically therein and secured thereto, forming an annular space between the two, an open-centred conically-inclined plate forming an annular throat-way radially converging outward into said annular space, means for supplying the material to be treated to said throat-way, an annular air-chamber at the top of said second vessel, air-inlet openings to said air-chamber, and perforations in the wall of said second vessel, both within and without said air-chamber.

14182. M. H. Miller, D. Huether, A. H. Hough, A. McNeill, and R. Fisher, Wiarton, Canada. *Improvements in the process of and apparatus for making sugar.* 25th June, 1903. This invention relates to sugar making, and is especially applicable to the manufacture of sugar from beet juice. It is also applicable in the manufacture of sugar from sugar cane juice, and from molasses. Its object is to produce a most efficient method and apparatus for purifying the juice preparatory to the crystallisation of the sugar. The method of purifying consists in passing an electric current through said juice while the same is in motion, maintaining the juice at a high temperature meanwhile, filtering said juice, passing sulphurous vapours through

said juice, and maintaining said juice at a high temperature while said vapours are passing therethrough.

15274. W. T. WHITEMAN, London. (Communicated by The Syndicat pour l'Exploitation du Brevet Hlavati, Brussels, Belgium.) *An improved process for extraction of the crystallisable sugar contained in saccharine liquids obtained from beetroot or sugar cane.* 10th July, 1903. This invention consists in a process for the elimination by the aid of hydrofluosilicic acid of the salts of potash contained in saccharine liquids obtained from beetroot or sugar cane, which process is characterised by the introduction into the said liquids of the said acids in the form of hydrofluosilicate of ammonium, the ammonia whereof is afterwards evaporated, and by the addition of lime for combination with the acid not in combination with the salts of potash, as it becomes liberated by evaporation of the ammonia.

20575. M. L. DE LA CAMARA and F. R. EGANA, Granada, Spain. *Process of extracting cellulose from sugar cane trash, pulp or residues, and similar products for making pulp for paper, pasteboard and the like.* 20th September, 1902. This chemical process for producing pulp for paper, pasteboard and like products, consists essentially (1) in digesting the trash and residue of the sugar cane and similar products, such as a sorghum corn, reeds, &c., in a bath of soda lye, the temperature of the bath being gradually raised to 60° C.; the products to be treated being then introduced at that temperature and allowed to remain in the bath for from 45 minutes to 60 minutes according as they are fresh products or residues coming direct from the sugar factory or are dry products; (2) in bleaching the pulp thus obtained by submitting it to the action either of a current of sulphurous anhydride or of a solution of chloride of lime.

GERMAN—ABRIDGMENTS.

143709. ALPHONS HEINZE, Magdeburg. *Apparatus for cleaning beetroot washing troughs.* 28th December, 1902. The apparatus consists of a frame resembling a plough which is drawn through the washing troughs. In passing through the washing troughs the cutting edges of the frame clear the trough of sludge.

IMPORTS AND EXPORTS OF SUGAR (UNITED KINGDOM,)

To end of September, 1902 and 1903.

IMPORTS.

Raw Sugars.	Quantities.		Values.	
	1902.	1903.	1902.	1903.
	Cwts.	Cwts.	£	£
Germany	5,111,361	3,707,895	1,763,284	1,545,138
Holland..................	270,278	170,559	86,170	65,364
Belgium	493,369	626,217	175,631	260,631
France	1,659,732	517,392	640,241	226,731
Austria-Hungary	83,408	1,521,912	27,888	636,623
Java	....	318,373	....	154,532
Philippine Islands	....	70,646	....	25,285
Peru	93,962	277,978	32,511	114,163
Brazil	519,289	67,156	171,309	26,219
Argentine Republic........	546,866	409,672	200,877	184,709
Mauritius	263,696	264,040	92,566	94,226
British East Indies	159,645	187,958	57,917	69,563
Br. W. Indies, Guiana, &c.	1,167,561	556,309	683,593	335,089
Other Countries	125,380	958,675	48,465	434,313
Total Raw Sugars......	10,494,547	9,654,782	3,980,452	4,172,586
Refined Sugars.				
Germany	10,585,124	11,909,197	5,513,364	6,223,594
Holland..................	1,828,169	1,677,692	1,050,477	974,266
Belgium	125,288	100,572	72,372	58,952
France	2,081,849	684,872	1,085,487	387,544
Other Countries	11,391	864,470	5,639	428,140
Total Refined Sugars ..	14,631,731	15,236,803	7,727,339	8,072,496
Molasses	991,110	1,145,978	189,033	210,300
Total Imports	26,117,388	26,037,563	11,896,824	12,455,382

EXPORTS.

British Refined Sugars.	Cwts.	Cwts.	£	£
Sweden and Norway	31,397	19,914	17,394	10,482
Denmark	101,408	73,630	51,799	40,055
Holland	50,532	49,675	26,369	26,785
Belgium	7,323	6,820	3,733	3,453
Portugal, Azores, &c.	6,890	5,972	3,434	3,271
Italy	17,774	6,772	8,353	3,100
Other Countries	315,596	531,432	187,577	323,987
	530,920	694,215	298,659	411,133
Foreign & Colonial Sugars.				
Refined and Candy	38,569	33,907	24,175	20,805
Unrefined	66,060	48,471	33,226	25,351
Molasses	2,437	1,411	937	690
Total Exports	637,986	778,004	356,997	457,979

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1903. Tons.		1902. Tons.
Total Receipts, 1st Jan. to Oct. 15th ..	1,374,037	..	1,424,594
Receipts of Refined ,, ,, ,, ..	1,264	..	16,953
Deliveries ,, ,, ,, ..	1,340,417	..	1,432,379
Consumption (4 Ports, Exports deducted) since 1st January	1,380,819	..	1,396,806
Importers' Stocks (4 Ports) Oct. 14th ..	36,005	..	17,526
Total Stocks, Oct. 28th	129,000	..	164,977
Stocks in Cuba ,, ...	126,000	..	92,464
	1902.		1901.
Total Consumption for twelve months ..	2,566,108	..	2,372,316

CUBA.

STATEMENT OF EXPORTS AND STOCKS OF SUGAR, 1902 AND 1903.

(Tons of 2,240lbs.)	1902. Tons.		1903. Tons.
Exports	691,657	..	826,108
Stocks	131,544	..	158,593
	823,201	..	984,701
Local Consumption (nine months)	31,750	..	30,720
	854,951		1,015,421
Stock on 1st January (old crop)	19,873	..	42,530
Receipts at Ports up to 30th September..	835,078	..	972,891

J. GUMA.—F. MEJER.

Havana, 30th September, 1903.

UNITED KINGDOM.

STATEMENT OF IMPORTS, EXPORTS, AND CONSUMPTION FOR NINE MONTHS ENDING SEPTEMBER 30TH.

SUGAR.	Imports. 1903. Tons.	Imports. 1902. Tons.	Imports. 1901. Tons.	Exports (Foreign). 1903. Tons.	Exports (Foreign). 1902. Tons.	Exports (Foreign). 1901. Tons.
Refined	761,840	731,586	739,491	1,695	1,928	3,213
Raw	482,739	524,727	497,938	2,423	3,303	4,750
Molasses	57,299	49,555	69,807	71	122	2,513
Total	1,301,878	1,305,868	1,307,236	4,189	5,353	10,476

HOME CONSUMPTION.

	1903. Tons.		1902. Tons.		1901 Tons.
Refined	707,812	....	728,692	....	—
Raw	395,051	....	493,786	....	—
Molasses	51,015	....	46,713	....	—
Total	1,153,878	....	1,269.191	....	—
Less Exports of British Refined	34,711	....	26,546	....	—
Net Home Consumption of Sugar	1,119,167	....	1,242,645	....	1,238,831*

* Trade estimate.

STOCKS OF SUGAR IN EUROPE AT UNEVEN DATES, OCT. 1ST TO 28TH, COMPARED WITH PREVIOUS YEARS.

IN THOUSANDS OF TONS, TO THE NEAREST THOUSAND.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	TOTAL 1903.
113	291	407	55	94	961

	1902.	1901.	1900.	1899.
Totals	1034 ..	469 ..	280 ..	419

TWELVE MONTHS' CONSUMPTION OF SUGAR IN EUROPE FOR THREE YEARS, ENDING SEPTEMBER 30TH, IN THOUSANDS OF TONS.

(From Licht's Monthly Circular.)

Great Britain.	Germany	France.	Austria.	Holland, Belgium, &c.	Total 1902-03.	Total 1901-02.	Total. 1900-01.
1709	817	575	387	503	3992	4033	4182

ESTIMATED CROP OF BEETROOT SUGAR ON THE CONTINENT OF EUROPE FOR THE CURRENT CAMPAIGN, COMPARED WITH THE ACTUAL CROP OF THE THREE PREVIOUS CAMPAIGNS.

(From Licht's Monthly Circular.)

	1903-1904. Tons.	1902-1903. Tons.	1901-1902. Tons.	1900-1901. Tons.
Germany	1,830,000 ..	1,748,556 ..	2,304,924 ..	1,984,186
Austria	1,200,000 ..	1,057,692 ..	1,302,038 ..	1,094,043
France	810,000 ..	833,210 ..	1,183,420 ..	1,170,332
Russia	1,250,000 ..	1,215,000 ..	1,098,983 ..	918,838
Belgium	240,000 ..	215,000 ..	334,960 ..	393,119
Holland	135,900 ..	102,411 ..	203,172 ..	178,081
Other Countries.	385,000 ..	350,000 ..	393,236 ..	367,919
	5,850,000	5,521,869	6,820,733	6,046,518

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All Advertisements to be sent *direct*.

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☞ The Editor is not responsible for statements or opinions contained in articles which are signed, or the source of which is named.

Blyth Bros. & Co., Mauritius, report shipments of sugar from August 1st to October 14th at 30,315 tons, as compared with 23,803 tons in the corresponding period of 1902-03. Of this, 25,905 tons went to India, 2,107 tons to the United Kingdom, and 1,668 tons to Australasia.

Mauritius.

It is expected that the present crop in Mauritius will be the largest on record and may even reach 200,000 tons. Returns from plant cane of 40 tons to the acre are quite common, and the juice being of more than average sweetness, very high yields of sugar are being obtained. A noticeable feature of the crop is the exceptionally high returns that have been given by the White Tanna Cane, a bud variation from the Stripped Tanna, of comparatively recent origin; high returns are also being obtained from the Seedlings 33 and 80. The market prices are satisfactory, fully a rupee per cwt. higher than last year. Rs. 9·95 has been given for extra fine quality first white sugar, ordinary good quality being firm at Rs. 9·50.

Papers on Java.

We are hoping shortly to publish some more articles from the pen of Mr. H. C. Prinsen Geerligs, the well known Java sugar expert, whose papers in our columns a few years back aroused so much interest. These will include an article on the Java Sugar Industry in general, and some account of the methods by which the cane is planted and manured in that country. In the present number appears some account of the Geerligs-Hamakers process of total exhaustion of sugar cane bagasse, from which it will be seen that a further very considerable saving of sucrose is rendered possible to the enhancement of the crop profits.

Presentation to Mr. George Martineau.

An interesting little meeting, the outcome of the abolition of the sugar bounties, took place at Messrs. Henry Tate and Sons' offices in Mincing Lane, on the 25th ultimo. It was convened to make a presentation to Mr. George Martineau, C.B., on behalf of the sugar refiners in the United Kingdom in grateful acknowledgment of his past services in their cause. The meeting was presided over by Mr. Edwin Tate, Chairman of the Sugar Refiners' Committee, and he was supported by Sir H. Tate, Bart., Messrs. Ernest Tate, R. P. Lyle, Muir (Manager of Tate's), Robert Kerr (Chairman of the Clyde Sugar Refiners' Association), C. J. Crosfield (Chairman Lancashire Sugar Refiners' Association), and L. A. Martin (Secretary of the Sugar Refiners' Association).

The presentation consisted of a silver gilt cup and stand of Georgian work on an old Irish pattern, a very fine specimen of art. It bore the following inscription: "Presented to George Martineau, Esq., C.B., by the Sugar Refiners of Great Britain in recognition of his long and arduous services in connection with the abolition of the Bounties on Sugar, November, 1903." The cup was further accompanied by a cheque for 500 guineas. Mr. Edwin Tate, who made this presentation, gracefully alluded to the great debt of gratitude which the sugar refiners owed Mr. Martineau for the way in which he had worked on their behalf for more than 30 years to secure the abolition of the sugar bounties; he expressed the opinion that no one else could have brought to bear all the knowledge which Mr. Martineau possessed of the whole question, and of the many negotiations with foreign countries which had occupied the attention of so many conferences during the period mentioned. He was supported by Mr. Crosfield, as representing Lancashire, and by Mr. Kerr, as representing the Clyde.

Mr. Martineau in reply thanked the refiners for the present they had made him, and said that the cup was a mark of the friendship of the sugar refiners with whom he had worked so long in perfect harmony, and which he and his children after him would value as a token of their goodwill to him. He expressed the opinion that the effect of the Brussels Convention would take some considerable time in making itself felt, but that when the sugar trade of the world settled down to a proper basis there would again be a fair margin for sugar refining in this country.

A further presentation of a lovely silver bowl was then made to Mr. Martin, who has rendered valuable services to the sugar refiners as Hon. Secretary of their Association for many years, when mention was specially made of his able conduct of the negotiations between the sugar refiners and H.M. Customs.

MACERATION OF BAGASSE.

In the February number of this Journal (page 54) we made some reference to Mr. Prinsen Geerligs' new process of total exhaustion of sugar cane bagasse. This consists in macerating the bagasse from the second mill in a series of vessels with water in such a way that the bagasse first comes into contact with an already concentrated solution, gradually with more diluted ones, and finally with water. The exhausted bagasse from the vessels passes through a mill in order to get rid of the superfluous water, and is used as fuel just as ordinary bagasse.

A special commission, consisting of managers and chemists of factories, and of machinery agents, recently examined the process and gave the following verdict of it, as published in the *Archief von de Java Suikerindustrie* of 1903, page 983:—

"We assisted at the experiments made with the Prinsen Geerligs-Hamakers method of sugar extraction from bagasse, made at the Wonopringgo factory, in the residency of Pekalongan, Java, from 11-14 September, 1903, and give here our opinion, based on the results obtained during these experiments and on other facts, derived from former experiments made during this grinding season, experiments extending over an amount of 2000 tons of cane.

1. The condition which the bagasse must possess for being properly treated in the battery is that it ought to be fine and regularly crushed, such as can be obtained by having been passed through a cane shredder or crusher and double crushing with mills.

2. The experiments were made in a diffusion battery, which was orginally used for the diffusion of cane-chips, and had a capacity of 280-300 tons of cane per 24 hours. This battery proved to have a sufficient capacity for the maceration of the bagasse from 450 tons of cane per 24 hours, with a loss on extraction of 0·25 parts of sucrose on 100 parts of cane, and a dilution of 19·6 parts on 100 parts of normal juice.

3. The increased extraction brings along with it a dissolution of non-saccharine matter; whilst the quotient of the juice extracted from the bagasse by a third mill was six points inferior to that of the first mill's juice, the juice extracted from that same bagasse by the maceration process had a quotient of purity differing by from eight to eleven points from that of the same first mill's or normal juice. The clarified juice from the mixture of mill juice and maceration juice was 0·7% less in purity than the clarified juice from the same cane extracted by treble crushing.

4. The moist bagasse from the maceration vessels could easily be deprived of its superfluous water by one three-roller mill and then showed an amount of moisture ranging from 45-50%, with an

Although these changes have only been brought about within the last few years, it is already proposed to modify at one and the same time the weights and the temperature, so as to standardise the measures, by taking a weight of 20 grammes in 100 cc. at the temperature of 20° C.

It is not my business to discuss the advantages and disadvantages of this last temperature. It is admittedly easier to obtain, in summer, than that of 15°, especially in hot countries where the chemists find great facilities for work. But I might remark that it cannot be a matter of indifference choosing a certain number as the normal weight, at least from a theoretical point of view. In short, it has been known for some time that the rotating power of sugar is not constant; the latest experiments, to the best of my knowledge, are those of MM. Nasini and Villavecchia, published in 1891. They have been carefully calculated at the temperature of 20°; the results given by these writers are thus very appropriate for the discussion I propose to offer here.

They found that for richnesses lying between 3 and 65 per cent. the rotating power might be represented by a formula of three terms:

$$\alpha_0 = a + bp - cp^2$$

in which we find

$$a = 66{\cdot}438^\circ$$
$$b = 0{\cdot}010312$$
$$c = 0{\cdot}00035449$$

This formula admits a true maximum, for the first result equal to zero gives

$$\frac{d\alpha_0}{dp} = b - 2cp = 0$$

from which

$$p = \frac{b}{2c} = \frac{0{\cdot}010312}{0{\cdot}00070898} = 14{\cdot}544$$

It is therefore with a weight of about 14·5 dissolved in a volume of 100 cc. at 20° C. that the rotating power is at its maximum. The rotation produced is, after Biot's formula:

$$\alpha = \frac{\alpha_0 lp}{v} = \frac{\alpha_0 \times 2 \times 14{\cdot}544}{100}$$

and the formula above gives

$$\alpha_0 = 66{\cdot}513$$

from which we find

$$\alpha = 19{\cdot}34^\circ = 19^\circ\ 20'$$

But the exact determination of a maximum is always very difficult, and, without admitting the perfect accuracy of the coefficients of MM. Nasini and Villavecchia, we may at least accept as certain the following two points:

1. The existence of a maximum, for the same form of function has been already given by Tollens in 1884 for a temperature of 17·5°.

2. Its value attains at least to 66·513, with a rotating power corresponding to the maximum.

The particular character of a maximum or minimum is that, in general, the function varies very slightly before and after the point, and therefore one may, without error, consider the maximum value of α_0 as constant within certain limits. In making the necessary calculations, the following values are found:

When p = 3	$\alpha_0 = 66{\cdot}466$
5	$\alpha_0 = 66{\cdot}476$
10	$\alpha_0 = 66{\cdot}506$
14·544	$\alpha_0 = 66{\cdot}513$
15	$\alpha_0 = 66{\cdot}503$
16·29	$\alpha_0 = 66{\cdot}510$
20	$\alpha_0 = 66{\cdot}502$
26	$\alpha_0 = 66{\cdot}466$

From this we see that the value of α_0 when p = 16·29 differs very little from the maximum, but that the error is already sensible for 20 gr. and much more for 26 gr.

In the employment of the polariscope for saccharimetry, it is specially in the neighbourhood of the point 100 in the saccharimetric scale that it is important to have great sensibility and likewise an exact proportion between the graduations and the degrees of richness. Biot's formula

$$\alpha = \frac{\alpha_0 \mathrm{p}}{50}$$

supposes implicitly that α_0 is constant, and, since that condition is not satisfied by the sugar, it is clear that this saccharimetric graduation does not represent accurately throughout its length the corresponding proportions of sugar.

I hasten to add that this criticism is more theoretic than practical, for the precision of the observations is not sufficient at present to detect the differences with any certainty.

But we may at least benefit by the assurance that α_0 is practically constant in the neighbourhood of p = 15 gr., and choose as the normal a figure approximating the latter, so as to obtain a strict proportionality of divisions and degrees of richness extending over the greatest extent possible of the scale.

Bearing this in mind, we find the weight of 16·29 gr. is, amongst all those suggested, the one which the most approaches the theoretic conditions desired. The corresponding rotation is

$$\alpha = \frac{66{\cdot}510 \times 16{\cdot}29}{50} = 21{\cdot}67^\circ = 21^\circ\ 40'$$

which is exactly the value adapted for the graduation of our instruments.

The weight of 20 gr. gives

$$\alpha = \frac{66{\cdot}502 \times 20}{50} = 26{\cdot}60^\circ$$

That of 26 gr. gives

$$\alpha = \frac{66{\cdot}466 \times 26}{50} = 34{\cdot}562^\circ$$

It is the last figure that ought to serve as the base for the present German division. On this scale, the weight of 16·29 gr. corresponds to a rotation of

$$\alpha = \frac{66{\cdot}466 \times 16{\cdot}29}{50} = 21{\cdot}65^\circ$$

so that the exact rotation given by this weight is 21·67°. The error of 0·02° represents $72'' = 1'\frac{2}{10}$; but 100° (saccharimetric) being equal to 34·562°, we find that 1° equals $2_0'$ and $\frac{1}{10}$ of degree 2′. The difference, $1'\frac{2}{10}$, is equivalent therefore to more than $\frac{1}{20}$ of a saccharimetric degree.

The instruments in actual use are not as a rule sensible enough to render this small difference noticeable. But with the aid of progress we may hope to attain to such a sensibility, for it is already possessed by certain instruments, successfully used by their constructors.

The same calculation applied to the weight of 20 grammes and compared with that of 16·29 also yields an error, but decidedly smaller.

If we take Biot's formula and its differential by relation to α and to p, it gives

$$d\alpha = \frac{\alpha_0}{50}\,dp$$

If we consider a similar variation of the weight dp = 0·01 gr. for example, employed with different values of α_0, we find

$$\text{For } p = 16{\cdot}29 \quad .. \quad .. \quad d\alpha = \frac{66{\cdot}513 \times 0{\cdot}01}{50} = 0{\cdot}013303^\circ$$

$$\text{,,} \quad p = 20 \quad .. \quad .... \quad d\alpha = \frac{66{\cdot}502 \times 0{\cdot}01}{50} = 0{\cdot}013300^\circ$$

$$\text{,,} \quad p = 26 \quad .. \quad .. \quad d\alpha = \frac{66{\cdot}466 \times 0{\cdot}01}{50} = 0{\cdot}013293^\circ$$

The actual variation of the weight 0·01 gr. thus produces the same difference of rotation, for the slight errors which the above figures indicate are not noticeable.

To continue; from a theoretic standpoint, and supposing we desire that the maximum rotating power should coincide with the point 100 of the saccharimeter, it is necessary to retain the weight of 16·29 gr. That of 20 gr. cannot be rejected *a priori*, but ought not to be adopted until a new scheme, produced by the most perfect instruments it is possible to manufacture, has shown whether Nasini and Villavecchia's formula is accurate enough to give a maximum value very near the mark.

If there were need for improvement in this point, one might conclude that the weight of 20 gr. ought to be preferred to that of 16·29 gr., but the contrary is equally possible.

In any case there is hardly any doubt that the weight of 26 gr. ought to be abandoned, since we are already justified in foreseeing that, with a polariscope sensible to $\frac{1}{20}$ of a degree (saccharimetric), we can discern a difference of a kind between the richness observed and the real one, when the latter is of 16·29 gr.

I have mentioned above that Tollens in 1884 gave, as an expression of the rotatory power of sugar, a formula of the form $\alpha_0 = a + bP - cP^2$, applicable from 0 to 67 per cent. Since 1878, another expression has been made known by him, only available between 0 and 18 per cent.; but, in both cases, he represents by P the weight of sugar per 100 in solution weight, and not the weight in 100 cc. These formulæ are hence not applicable without some alteration, but it suffices to retain their form, for they prove that a maximum exists.

As far back as 1877, M. Schmitz, while studying this subject, published an analogous formula

$$\alpha_0 = a + bq - cq^2$$

in which q represents the weight of water and not that of sugar.

If we replace q by 100 - P, as Landolt proposed, we obtain a formula invariably of the same form.

It is unnecessary to discuss each of these equations or to deduce therefrom the corresponding maximum value, for these observations are evidently encumbered with errors due to the imperfections of instruments 20 years old. But I considered it worth while showing that the different authors who have investigated this question have been led to represent their conclusions by equations of the same form. These latter involve the existence of a maximum, although I have never seen it specified until it was pointed out by M. Buisson several years ago.

There is hence no more discussion possible save on the actual value of this maximum; but when it has finally been determined, it will furnish a figure approaching to the normal weight, which ought to be chosen a little higher in order to profit by that part of the curve in which we consider the rotatory power to be constant.—(M. Demichel, in the *Bulletin de l'Association des Chimistes.*)

A straight line engine, in use at the works of the Solvay Process Company, in Syracuse, N.Y., recently completed a continuous run of 22 months, during which period it had not once been stopped. Its speed was 250 revolutions per minute, which makes 15,000 per hour, 360,000 per day, nearly 11,000,000 per month, and a grand total for the 22 months of some 241,000,000 revolutions without a stop. This speaks well for the excellence of the design and workmanship expended upon the engine, and for the excellence of the attendance received.—*Iron Age.*

LABOUR IN HAWAII.

A Report of the United States Commissioner of Labour upon the commercial, industrial, social, educational, and sanitary condition of the labouring classes of the territory of Hawaii has just recently been issued.

It appears to be a more or less complete vindication of the existing labour conditions in the Hawaiian Islands; these have often been the subject of attack by agitators and so called reformers, as has been also the case with the Australian and South African systems, and therefore this report of a disinterested unbiassed official should be worth studying.

Amongst other matters, the report deals with the present plantation labour supply, and with the measures taken to recruit labour for the islands; it treats in detail on the importation, of Chinese, Japanese, South Sea Islanders, Portuguese, Germans, and Norwegians under contract. Recruiting was undertaken in all corners of the earth, but apparently nowhere was a people found combining the civic capacity to build up a State with the humility of ambition necessary for a contract labourer.

The present plantation labour of Hawaii, exclusive of skilled labour and superintendence, is composed of a few Europeans and Portuguese from the Azores, Hawaiians, American Negroes, Porto Ricans, Chinese and Japanese. The Europeans include a few Italians who have come into the country from Louisiana, (where they work for the same wages upon the sugar plantations and live in the same quarters as do the Negroes), Galicians and Slavs from East Austria, and a few Germans. The Portuguese are largely employed in the semi-skilled occupations of the plantation, though some two-fifths are listed as field-labourers. These people are an exceedingly hopeful element of the population. They are both industrious and frugal, and their vices are not of a sort to injure their efficiency as workers. They make good citizens, and are becoming rapidly Americanized. It is rather significant, however, that they are not classed with "white men" on the plantations. They form a class apart, somewhere between Asiatics and the other Caucasians.

There are 1,369 Hawaiians employed on sugar plantations in all capacities. These natives are usually preferred for handling animals. On account of their superior strength they also make excellent wharfmen and porters, also as locomotive drivers and stokers, and similar mechanical positions. Comparatively few are field hands. They are reported to be good men when they work, but they lack industrial discipline. They are indisposed to regular labour day after day in any occupation of a monotonous character.

There are a few American Negroes in Hawaii. Over one hundred men and their families were imported from Louisiana a year or two back, and were paid from $18 to $24 a month. Very few remained by the end of 1902, and those who were left were earning salaries as hospital nurses, or policemen; only half a dozen or so remained in the fields. In a word, the experiment of importing black labour from the States was a failure; and socially, the negro is an undesirable settler in the Islands. The Hawaiians include the original rulers, nobility, and landowners of the islands, and not being racially allied with the negro, they do not desire social intercourse with the latter.

The Porto Ricans, when they arrived, gave the least promise either as citizens or labourers. They had been carelessly recruited and suffered from the long voyage. They were half-starved, anaemic, and, in some cases, diseased people from the coffee country of Porto Rico, where the hurricanes of 1899 had thrown them out of employment. They were not so much representatives of the people of Porto Rico, as of famine and misery. They suffered exceedingly from the journey (via San Francisco in winter) and many of them on arrival went straight to the hospitals, and some never left them alive. The rest had to be specially looked after and fed, taught how to live in their new surroundings, and to generally acquire the new habits of life necessary to their changed condition. A considerable number developed into strollers and vagabonds; they did not, however, have all their own way in this kind of life. Social regime in Hawaii is strict. Any industrious and able-bodied man can always find employment, and the planters consider that a man who doesn't work is bound to steal, and he is treated and watched accordingly. However, a fair number of the Porto Ricans are meeting the emergency with credit, and are acquiring habits of persistent industry which they might never have gained in their own country. Their actual monthly earnings for plantation work probably average between $18 and $19.

One advantage of the immigration of Porto Ricans was the curb it placed on the Japanese, who had begun to fancy that with the enforcement of the Federal Chinese exclusion and contract laws they would become complete masters of the labour situation. They tried to organize strikes, but the arrival of the Porto Rican labourers made them ultimately more reasonable in their relations with their employers. Now and then quarrels arise between the Porto Ricans and the Japanese. The latter are seldom the aggressors, but when their blood is up, will stop little short of extirminating the local Porto Rican population, unless prevented. The customs of the two peoples are so different that trouble is apt to ensue if they are placed in neighbouring quarters. The Japanese for instance, have a naive disregard for proprieties of costume, and occasionally walk about their camps in

an absence of attire that Americans or Europeans tolerate only in works of art. Porto Ricans object to this in the case of adults, and one or two riots have been the result. On the other hand his careless disregard for cleanliness renders the Porto Rican a less pleasant neighbour or employee than an Oriental. But despite all his faults, he appears more desirable as a permanent settler, and ought to turn out in course of time a fairly intelligent and industrious citizen.

Next comes the Chinaman. He has long been one of the most important elements of Hawaii's working population, and has possessed more influence and privilege than have his brethren in the United States. The Chinese coolie appeared in Hawaii in 1852. He accumulated property, intermarried with the natives, learnt their language, and generally settled himself amongst them. In the marshy coast regions and fertile mountain valleys he started profitable rice plantations. But the number of Chinese immigrants eventually caused disquietude, and from 1883 a growing opposition to their continued importation manifested itself. With the advent of labour from Japan, a Chinese restriction act was passed in 1888 which virtually excluded them for a time. A limited number of field hands and domestics were, however, allowed to enter the country each year.

The planting interests have usually, though not unanimously, been in favour of Chinese labour. An ideal situation in the opinion of most managers would be to have a force of unskilled employees divided about equally between the two Oriental Nationalities. But the two peoples, in spite of their kinship, have marked dissimilarities. The Chinaman is usually the more steady and reliable, but the less energetic labourer of the two, and is preferred for irrigation and cane cutting. The Japanese has greater physical strength, and is the better man for loading and for general work in the mill. He is more frequently seen in charge of a team than is the Chinaman. He is also more cleanly about his person and more tidy about his surroundings, and adopts much more readily all the superficial tokens of Caucasian civilization. He wears European clothing, carries a watch, and seeks more eagerly for variety in life. He represents the Radical, the Chinaman the Conservative, side of Oriental life. His white employers consider him superficial and untrustworthy in business matters. His vices are more occidental than those of the Chinese. He does not fall a victim to opium, but is fond of intoxicants. He is usually kind to animals, and largely a vegetarian in his diet. When they first arrived in Hawaii, the Japanese could scarcely be persuaded to eat enough wholesome food to do a fair day's work. A Chinaman is said to spend half as much again on his provisions as a Japanese. He eats meat and is frequently to be

seen going home with a canvas-wrapped ham on his shoulders. In matters of business the Chinaman is considered far more reliable. He seldom deserts a contract even though he lose heavily, while a Japanese will walk off and leave his manager in the lurch if he fails to get what he considers a favourable bargain. A prominent business man of Honolulu who had been dealing with Chinese for over thirty years said that he had never lost a cent through their dishonesty, nor had any of them attempted to evade a business promise. They are also said to be constant in their domestic relations, and the descendants from Chinese-Hawaiian marriages are esteemed the best mixed race in the Territory.

The Japanese make more demands on a plantation manager in the way of quarters and general conveniences than do the Chinese. Many of them have families, and require individual apartments. They will not sleep in "double deckers," and prefer to board in small companies upon a cottage system, while the Chinese like to herd together in large barracks—usually roomy barn-like structures—with little suggestion of domesticity about them. It is difficult to keep Japanese employees on a plantation unless they are provided with plenty of water—preferably hot—for their daily bath. No provisions for privacy need accompany these arrangements—one big tub is sufficient for the lot.

The patriotism and national aggressiveness of the Japanese are factors of some importance. They do not separate themselves from home influences and government when they emigrate to other counties. Japan never lets go of its citizens, and does not intend that they shall form permanent ties in other countries. In this respect it differs from European emigration to the United States. Japanese financial institutions and steamship companies handle the savings of the labourers and carry the latter to and fro from the islands; while the Government of Japan closely supervises and regulates every detail of their emigration. It is said that only a certain number of Japanese are allowed to leave each province of their country; but as in a year's work in Hawaii they can save as much from their wages as in the better part of a lifetime in some of the rural districts in their own country, the voluntary labour supply from Japan has naturally filled the Hawaiian market, though always under the strict control of the Government. It is even rumoured that when the pressure for employment becomes great at home the local agents of the Japanese Government intervene to encourage a return to Japan of the labourers who have the largest deposits in the Japanese banks.

EXPERIMENTS WITH SEEDLINGS AND OTHER CANES AT BARBADOS, IN 1903.

A summary of the experiments with seedling and other canes in Barbados during 1901-3 has been published as a pamphlet by the Imperial Department of Agriculture for the West Indies, and we give below some portions of it as bear on some of the best species. The compilors wish once more to prevent hasty conclusions being drawn from the one year's work. A final decision is evidently still a matter of some years more, but there seems to be sufficient grounds for satisfaction with what has been accomplished so far.

The selected varieties were cultivated at nine estates situated in different typical localities, eight being black soil estates and one red soil estate. At the red soil estate and at three black soil estates first ratoons were included amongst the plots. In nearly every field, the seedlings grown upon it were arranged in duplicate plots.

Each plot consisted of 100 stools of canes, arranged in four rows of twenty-five stools. With but few exceptions, thirty stools were cut from the inner two rows, weighed, and sampled. By recording the results of the inner rows only, the effects of one variety upon the growth of another and less vigorous variety were eliminated.

From the thirty stools above mentioned, a sample of about 105 lbs. weight was taken by the mechanical method published in the *West Indian Bulletin*, Vol. I., p. 28. Of this sample 100 lbs. were crushed in the laboratory mill, the juice and megass weighed, and the juice analysed, from which data the results were calculated to the acre. The laboratory mill is a three-roller mill, the rollers being 18 inches long and of 12 inches diameter; it is driven by an 8½ horse-power oil engine.

Seedling Characters.

The following are the more important field and factory characters, a consideration of which goes to determine the value of any variety of cane.

Field Characters :—

1. Germinative power.
2. Behaviour under extremes of dryness and moisture.
3. Habit, that is whether upright or recumbent.
4. Power of resisting the attacks of insects and fungi.
5. Period of growth.
6. Productive power in tons of cane.
7. Tonnage of tops.
8. Ratooning power.

Factory Characters :—

9. Milling quality, that is whether the canes are tough or brittle.
10. Fuel producing property, depending upon the percentage of fibre.
11. The relative percentage of expressable juice (determining the "dryness" or "juiciness" of the canes).
12. The richness of the juice.
13. The purity of the juice.

As to the weather conditions, these were not of the best, and the results have been more or less adversely affected. Two droughts occurred (January to April, and September to November), with rainy weather intervening. The effect of these two droughts, together with the prevalence of the root disease, *Marasmius sacchari*, greatly reduced the value of many of the experiments.

The results of some of the chief seedlings are as follows:—

Jamaica or Mont Blanc Cane.

Of such close resemblance to White Transparent as to be practically undistinguishable; and as that cane is so well known, it is not described.

Chief mean results per acre:—

	Canes. Tons.		Saccharose. lbs.		Comparative order (by Saccharose yield).
Black soils, ratoons (mean of four plots)..	9·47	..	2,014	..	4
Red soils, ratoons (mean of two plots)....	19·24	..	4,624	..	1

The juice was fairly rich and pure, and suitable for muscovado manufacture. The number of rotten canes was small. The ratoon results on red soils were good.

Experimental sample of juice—results of six samples.

	Mean.
Saccharose, lb. per gallon	1·890
Quotient of purity	89·64
Glucose ratio..	3·07

Sealy Seedling Cane.

Of fairly good germinating power: from 10 to 14 rather slender canes to the clump; internodes slightly constricted, from 4 to 6 inches long; colour, dirty yellow often blotched with red, particularly if exposed to much sunshine; habit, upright; few arrows; drought resisting.

Chief mean results per acre:—

	Canes. Tons.		Saccharose. lbs.		Comparative order (by Saccharose yield).
Black soils, plants (mean of two plots) ..	20·23	..	4,613	..	7
Red soils, plants (mean of two plots)	26·06	..	5,431	..	2
Red soils, ratoons (mean of two plots) ..	19·07	..	4,172	..	4

The juice was unfavourable for muscovado manufacture. The number of rotten canes was a small average number. The results on black soils are poor but on red soils are good. The quality of the juice, as well as its doubtful milling properties, render it improbable that this otherwise promising variety can be adopted for muscovado estates.

Experimental samples of juice—results of six samples.

	Mean.
Saccharose lb. per gallon	1·731
Quotient of purity	81·86
Glucose ratio..	4·84

Estate samples of juice—results of five samples.

Saccharose lb. per gallon	1·884
Quotient of purity	87·53
Glucose ratio..	3·10

White Transparent Cane.

Chief mean results per acre:—

	Canes. Tons.	Saccharose. lbs.	Comparative order (by Saccharose yield).
Black soils, plants (mean of 18 plots) ..	21·10	5,172	5
Black soils, ratoons (mean of nine plots)..	11·22	2,602	2
Red soils, plants (mean of two plots) ..	15·31	3,687	8
Red soils, ratoons (mean of two plots)....	10·95	2,518	10

The juice was fairly rich and pure. The number of rotten canes was above the average. The results on the black soils were good, those on the red soil estates were unsatisfactory.

Experimental samples of juice—results of 31 samples.

	Mean.
Saccharose lb. per gallon	1·957
Quotient of purity	89·37
Glucose ratio..	3·11

Estate samples of juice—results of 50 samples.

Saccharose lb. per gallon	1·818
Quotient of purity	87·69
Glucose ratio..	3·76

B. 147 Cane.

A delicate slow-growing cane when young and one which does not appear to germinate freely when planted late in the season; from eleven to twelve canes to the clump. Of a bright yellow colour, with long cylindrical internodes of about 4 to 8 inches long, having a slight longitudinal channel on the side to which the bud is attached; very rarely arrows. There is a tendency for the sheaths of the fallen leaves to remain attached to the lower half of the cane until towards the close of the year, and for this reason the sleeping roots of the nodes begin to start into life; these, however, dry on being exposed, as the leaves fall. It is, on the whole, a hardy, vigorous, upright grower with considerable power for resisting periods of drought. A late ripener.

Chief mean results per acre :—

	Canes. Tons.		Saccharose. lbs.		Comparative order (by Saccharose yield).
Black soils, plants (mean of 18 plots) ..	22·53	..	5,269	..	4
Black soils, ratoons (mean of seven plots)	11·65	..	2,637	..	1
Red soils, plants (mean of two plots) ..	16 26	..	3,828	..	7
Red soils, ratoons (mean of two plots)....	5·74	..	1,293	..	12

The saccharose yield of this cane was in black soils plants and ratoons and red soils plants approximately equal to the White Transparent, being immediately above that variety in order in each of the corresponding tables. The red soil ratoon results were unsatisfactory. The juice in most cases was fairly rich and sufficiently pure for muscovado manufacture. The number of rotten canes was small.

Experimental samples of juice—results of 29 samples.

	Mean.
Saccharose lb. per gallon	1·835
Quotient of purity	87·04
Glucose ratio..	3·65

Estate samples of juice—results of 30 samples.

Saccharose lb. per gallon	1·795
Quotient of purity	86·74
Glucose ratio..	4·14

B. 208 Cane.

Germinates readily; from 10 to 15 canes to the clump; internodes from 3 to 5 inches long, somewhat cylindrical; colour greenish yellow; habit upright; average number of arrows; the dry leaves have a tendency to adhere; drought resisting.

Chief mean results per acre :—

	Canes. Tons.		Saccharose. lbs.		Comparative order (by Saccharose yield).
Black soils, plants (mean of eight plots).	20·38	..	5,329	..	2
Black soils, ratoons (mean of six plots) ..	7·68	..	1,751	..	5
Red soils, plants (mean of two plots) ..	19·96	..	5,443	..	1
Red soils, ratoons (mean of two plots)....	14·98	..	3,973	..	5

The juice was exceedingly rich and pure. The number of rotten canes was very small. The yield of saccharose from plant canes was on the average of all the plots slightly greater than any other variety. The black soil ratoons were not so good. In red soils, both plants and ratoons, the results were good and altogether this cane comes out experimentally as the best of the year.

Experimental samples of juice—results of 18 samples.

	Mean.
Saccharose lb. per gallon	2·127
Quotient of purity	90·55
Glucose ratio..	2·06

Estate samples of juice—results of 44 samples.

Saccharose lb. per gallon	2·043
Quotient of purity	90·03
Glucose ratio..	2·68

B. 376 Cane.

Of fairly good germinating power; from eight to ten canes to the clump; internodes from three to five inches long, of medium size, somewhat tumid; colour very variable, like White Transparent cane which it much resembles; in habit, too, it is like the White Transparent, while under certain conditions it is somewhat trailing and under others upright; few arrows; drops its leaves readily.

	Canes. Tons.		Saccharose. lbs.		Comparative order (by Saccharose yield).
Black soils, plants (mean of seven plots).	21·87	..	5,145	..	6
Black soils, ratoons (mean of one plot) ..	7·39	..	1,457	..	8
Red soils, plants (mean of two plots) ..	20·13	..	4,792	..	4
Red soils, ratoons (mean of one plot)....	17·37	..	3,908	..	6

The juice was rich and pure. The number of rotten canes was comparatively high. The results are fair, but while justifying further trial do not indicate any superiority on the part of this variety.

Experimental samples of juice—results of eleven samples.

	Mean.
Saccharose lb. per gallon	1·899
Quotient of purity	89·55
Glucose ratio..	3·24

The Selected Varieties arranged in Order of Yield, to Show the Relative Position and Purity of Juice of Certain Canes in different soils and also when grown as Plants and Ratoons.

All soils (plants).

	Yield of Saccharose in lbs. per acre.	Purity of juice.		Yield of Saccharose in lbs. per acre.	Purity of juice.
B. 208.. ..	5,352 ..	very high.	Sealy Seedling ..	5,022 ..	low.
B. 147	5,125 ..	fair.	D. 95	4,272 ..	fair.
B. 376.. ..	5,067 ..	high.	B. 635 ..	2,416 ..	fair.
White Transparent	5,023 ..	high.			

All soils (ratoons).

D. 95	3,253 ..	fair.	B. 208 ..	2,307 ..	very high.
Jamaica Cane	2,884 ..	high.	B. 390	2,099 ..	high.
B. 376.. ..	2,633 ..	high.	B. 379 ..	1,969 ..	high.
White Transparent	2,587 ..	high.	Rock Hall Cane ..	1,937 ..	fair.
B. 147.. ..	2.338 ..	fair.	B. 635 ..	907 ..	doubtful.

Black soils (plants).

Sport White.	5,942 ..	fair.	B. 376 ..	5,145 ..	high.
B. 208	5,329 ..	very high.	Sealy Seedling	4,613 ..	low.
B. 645.. .	5,322 ..	high.	D. 95 ..	4,351 ..	high.
B. 147	5,269 ..	fair.	B. 635	2,056 ..	fair.
White Transparent ..	5,172 ..	high.			

Black soils (ratoons).

	Yield of Saccharose in lbs. per acre.	Purity of juice.		Yield of Saccharose in lbs. per acre.	Purity of juice.
B. 147	2,637	fair.	B. 390	1,664	high.
White Transparent	2,602	high.	B. 379	1,546	high.
D. 95	2,025	fair.	B. 376	1,457	high.
Jamaica Cane	2,014	fair.	Rock Hall Cane	1,058	doubtful.
B. 208	1,751	very high.	B. 635	623	doubtful.

Red soils (plants).

B. 208	5,443	very high.	B. 147	3,828	fair.
Sealy Seedling	5,431	low.	White Transparent	3,687	high.
B. 390	5,091	high.	B. 379	3,532	very high.
B. 376	4,792	high.	B. 619	2,980	low.
B. 393	4,174	high.	B. 635	2,775	doubtful.
D. 95	4,035	high.			

Red soils (ratoons).

Jamaica Cane	4,624	very high.	B. 390	3,836	fair.
B. 379	4,527	very high.	Rock Hall.	3,694	high.
D. 95	4,480	high.	White Transparent	2,518	high.
Sealy Seedling	4,172	low.	B. 254	2,046	doubtful.
B. 208	3,973	very high.	B. 147	1,293	doubtful.
B. 376	3,908	high.	B. 635	1,190	doubtful.
B. 373	3,903	low.	B. 619	591	low.

Freedom from rotten canes.			Germinative power of plants.	Germinative power of ratoons.
B. 373	none		Good.	Good.
B. 619	·77	less than average number.	Medium.	Medium.
B. 208	·96		Good.	Good.
B. 393	1·33		Medium.	Medium.
B. 635	1·36		Medium.	Medium.
Rock Hall	1·37		Medium.	Medium.
B. 147	1·75		Medium.	Medium.
B. 390	2·24		Good.	Good.
Jamaica	2·32		Good.	Good.
Sealy Seedling	2·63	*average	Good.	Good.
B. 645	2·79		Good.	Good.
B. 379	2·80		Good.	Good.
B. 254	3·53	more than average number.	Medium.	Medium.
White Transparent	4·19		Good.	Good.
B. 376	4·82		Good.	Good.
D. 95	5·62		Good.	Good.
Sport White	6·49		Good.	Good.

*The average percentage was 2·92 for the whole series.

General Conclusions from the Variety Experiment Plots of 1903.

The weather this year, which reduced the crop of the island to less than two-thirds of the average, was exceedingly unfavourable to experimental cultivation and renders the results, taken alone, of little value for drawing conclusions. Such weather of course serves to bring out the resistive qualities of the several varieties and to show, how under adverse circumstances new varieties will compare with the old and standard varieties.

Under such circumstances it is to be noted the Barbados Seedling 208, on the whole, maintained its place, both as to yield and richness and purity of juice: that White Transparent and B. 147 ran almost neck and neck in yield but the latter was slightly behind in the richness and purity of its juice: and the Sealy Seedling while showing a favourable yield again broke down on the quality of the juice. The results therefore, on the whole, confirm those of previous years.

New Seedlings.

This year a very large number of new seedlings have been crushed and analysed and the results will be found in the large annual report of the Agricultural Experiments at Barbados.

These results are there published as a record of the work done and are simply used as a guide in the process of eliminating valueless seedlings from further experimental cultivation. The cultivation of the more promising varieties will be continued and some of them may ultimately rise to the rank of selected seedlings to be tested at the local stations: a report on the results will then be included in the annual pamphlet.

WEST INDIAN SUGAR IN CANADA.

The following information respecting West Indian sugar in the Dominion of Canada has been furnished to the *Agricultural News* by Mr. T. Russell Murray, formerly of Port-of-Spain, Trinidad, recently appointed correspondent of the Imperial Department of Agriculture at Montreal.

The sugar market in Canada has its centre mainly in Montreal; here are situated the largest refineries. Eighty per cent. of the sugar used in Canada is white granulated beet and is imported from Europe and the United States, both refined and raw. A small quantity of beet is being grown in Canada for local manufacture; but considerable doubts are being expressed regarding the prospects of beet growing. To a large extent, the sugar market throughout the Dominion is subject to trade conditions, governed, in the main, by the sugar refiners, who only sell, through brokers in the various cities, to the wholesale grocery trade and manufacturers, who in turn supply the retail trade. Under such circumstances, it is largely incumbent

upon the lesser to deal with the greater to ensure continuous business; hence certain difficulties are encountered in introducing high grade West Indian sugar for table use, as it cuts out the Canadian refined and naturally interferes with the linked relationship of the wholesale trade to the refiner, and the wholesale with the retail trade.

There is, however, a general feeling among consumers in favour of cane sugar, and it lies with the West Indian planters to produce a good, bright, yellow, soft sugar, with not much crystal and uniform in colour. The colour, once above No. 16 Dutch Standard, should be as bright a yellow to primrose colour as possible. For summer and autumn fruit preserving, the colour is not so important, but dark sugars are extremely difficult to sell to refiners.

The position of the tariff is as follows, say for 88° under Dutch Standard for German beet:—

British West Indian, 88°.	c.
Duty on 75°	40
Duty on 13° at 1½c. per degree	19½
88°	59½
Less preferential, say..	20
	39½
German beet, 88°.	
Duty on 75°	40
Duty on 13° at 1½c. per degree..	19½
88°	59½
Add 30 per cent. surtax, say..	17¾
	77¼

or 37¾ c. per 100 lbs. in favour of the British West Indian.

For sugar above 16 Dutch Standard, duties work thus for, say, 88°; duty, per 100 lbs., $1·08, and for over 81°, per each degree, 1¼c.

For the encouragement of refiners in Canada the tariff stands as under:—

IN CANADA.	Dollars.	C.
Duty on Austrian granulated beet and bags ..	1·28	
Duty on Austrian raw beet and bags	62½	
		65½
IN UNITED STATES.		
Duty on Austrian granulated beet	1·95	
Countervailing against export bounty	·29	
	2·24	
Duty on raw beet from Austria	1·55	
Countervailing duty	·20	
	1·75	
Protection given to the United States refiners ..		49
Balance		16½

Hence Canada gives 16½c. per 100 lbs. more protection than the United States, and under such auspices, Canada offers a better market for British West Indian sugars than even the United States.

SUGAR IN PORTO RICO.

A GENERAL DESCRIPTION OF THE GUANICA CENTRAL.

By D. L. Thomson, A.M.I.Mech.E.

(late) Chief Engineer.

When Porto Rico became American territory after the War of 1898, the sugar planters then found themselves in the fortunate position of having a free market for their produce in the U.S.A., and it was not long until American capitalists saw the great possibilities awaiting the industry there. One large factory, Central Aguirre, was erected three years ago, and the Guanica Central described below is a similar undertaking on an even larger scale. Both these factories are on the south side of the island, which unfortunately suffers much from droughts, and irrigation is an absolute necessity, the water being usually obtained by pumping from driven wells. The factories own or lease about half of the land in cultivation, and the other half is in the hands of *colonas* or farmers, who receive the equivalent of 5 to 5½% of first sugar per ton of cane loaded into the company's cars. There is practically an unlimited supply of native labour for the cultivation, and wages are from 40 to 50 cents per day. Tradesmen, however, get from 1 dollar to 2½ dollars per day, and a few even as high as 3½ dollars. The United States immigration laws, preventing the importation of contract labourers, tend to keep out the very capable black tradesmen from neighbouring islands, who do not usually make more than from 60 cents to 1 dollar. The soil of Porto Rico is very fertile, and with efficient irrigation may be depended upon to yield nearly 40 tons of cane per acre, and in some places it has already yielded over 60 tons per acre.

In the following description of the Guanica Central it is to be noted that tons are 2,000 lbs., and gallons are U.S.A. gallons, which are equal to ·83 of an imperial gallon.

All the buildings are of structural iron and steel, covered with galvanized sheets, windows fitted with steel folding shutters, and main entrances closed with steel roller shutters. The main building, consisting of mill house, pump room, and centrifugal department on the ground floor, covers an area of 147 ft. long by 284 ft. wide. The central part of the main building, called the boiling house, is three storys in height, the ground floor being occupied by the juice heaters, hot filtered juice tanks, tanks for "bottoms" of filters, filter press juice tanks with their corresponding pumps, the vacuum pumps, and the centrifugals. The second floor of the boiling house, which is 20 ft. higher, 147 ft. long by 92 ft. wide, contains the mechanical filters, filter presses, defecated juice tanks, Grevenbroich crystallizers, washing

machine and hydro-extractor for filter press cloths with electric motor for same. The third floor, 19 ft. higher and of same dimensions, is occupied by the defecators, Lillie quadruple effet, three vacuum pans, and syrup and molasses tanks. Provision is made for two more pans and an additional evaporator. The mill house on one side is 147 ft. long by 121 ft. broad, in two bays, and the warehouse on the other side is of same length and 50 ft. wide, with a "lean-to" 21 ft. wide.

The machine shops and general store are in a separate building 161 ft. long by 45 ft. wide, to which adjoin the small brass foundry and locomotive shed.

The boiler shed is a building 207 ft. long by 45 ft. wide, semi-detached from the main buildings.

The power plant is a separate building 130 ft. long by 75 ft. wide, containing its own boilers, engines and generators, as described further on.

The general office, laboratory, and engineer's office are in a separate wooden building of two storys, and a large stable adjoins it. The administrator's bungalow, store, hospital, bakery, cottages for overseers, houses for engineers, and an hotel with accommodation for 80 guests are disposed around and convenient to the factory, while on the wharf, which is a quarter mile from the factory, there is a general store for cement, iron, pipes, paint, oils, &c., in bulk.

The wharf, which can accommodate vessels drawing 21 ft. of water, was built of limestone quarried from the adjoining rock, filled in with rubble, and the railroad runs alongside the steamers. Here also is a large steel tank, capable of holding 428,000 gallons, for storing second molasses previous to shipping. This tank is 50 ft. diameter by 30 ft. high, and connected to the pumps in the factory by 6 in. cast iron piping.

Railroad. There are about 11 miles of railroad belonging to the company, connecting with the French railroad to Ponce on the one side and eventually with Mayaguez on the other, each about 25 miles distant, 1 metre gauge, and rails 30 lbs. per yard. The steepest grade on the line made by the company is only 0·7 per cent. (1 in 143), and no difficulty is experienced in hauling trains of cane weighing 300 tons there, but unfortunately there are much steeper grades on the connecting lines. The canes are brought to the mill in cars 31 ft. long by 7 ft. wide, carrying about 10 tons, and about 250 are required. The trains are hauled by three Baldwin locomotives, 10 in. by 22 in. cylinders, six coupled, weighing each about 40 tons with water and coal, and one small Porter engine, cylinders 10 in. by 14 in., is used for shunting in the yard. The French Railroad Company use their own engines on their line, but require frequent assistance on their heavy grades, while the cars they provide are only of about half the capacity Nearly one half more cane can be packed in a car loaded by hand than in a car loaded by derrick or crane.

When the cane arrives at the factory it is hoisted out of the cars, five to eight tons at a time, according to the size and build of them, by an electric travelling crane, to which is attached a weighing machine, which stamps the nett weight of the cane on duplicate slips; the slings carrying the load are then tripped, and it falls into a hopper, from which it is elevated to the crusher by a steel apron inclined at an angle of 45°, and fitted with steel hook arms to grip the cane. The idea of having this steel inclined apron being to give a regular feed to the mills, all above the depth of the hook arms being supposed to fall back into the hopper; but unfortunately this does not happen in practice, as the canes get twisted up in heaps, so that some sort of revolving cutter fitted to this elevator is required to level down the feed to a uniform depth.

Mills. The mill plant consists of two duplicate trains, each having an elevator feeding a Krajewski crusher 26 in. by 72 in., driven by a 16 in. by 36 in. Corliss engine, then two 32 in. by 72 in. three roller mills, with intermediate maceration carrier of japanned corrugated steel slats. The mill engines are Córliss, 22 in. by 48 in., with compound gearing of ratio of 24 to 1.

The gudgeons are of fluid compressed steel, 17 in. diameter in body; top journals, 15½ in. by 21 in.; and side journals, 14 in. by 21 in.; and fitted with pinions at both ends, pinions being 5½ in. pitch and 15 in. face. The top roll only is flanged, and the rocker trash turner, which is 19 in. deep, is also provided with guides or "chokes," which, however, is a mistake, as they tend to choke the feed and also cause reabsorption, the megass spreading out on the ends of the back roll. I think there is little doubt that the old way of flanging the side rolls is the better, as the blanket of megass is kept practically the same width right through, and there is less danger of juice getting into the journals. The first mills have a hydraulic pressure of 314 tons on top roll, and the second mills 254 tons on back roll, which is equal to about 420 tons on top. All the gearing bearings are babbitted, which is a mistake, as the vibration shakes them loose; the side roller bearings are cast-iron, with only a thin brass liner. The pinions and segments of main spur wheel are cast-steel, but the intermediate wheel, which is cast in one piece, is semi-steel; first motion gear, 4 in. pitch, 12 in. face; second motion gear, 5 in. pitch, 14½ in. face.

The framing of all the carriers is steel, and driven by link belt chains, and the megass is conveyed to the furnaces and fed automatically through shoots, closed by flap doors, which are opened by a slowly revolving shaft fitted with trip arms.

Boilers. There are six 500 h.p. Stirling boilers, each having 5020 sq. ft. heating surface, in 314 3¼ in. ex.-lap. welded iron tubes; three steam drums, 42 in. diameter by 17 ft. 3 in. long; and one bottom drum, 42 in. diameter by 14 ft. 9 in. long. The working pressure is 125 lbs. square inch.

The steam valves are 10 in. bore, connected by 10 in. copper expansion bends to the 24 in. bore main steam pipe, which is wrought iron with cast iron flanges fixed on. The furnaces, known as Burt's patent, have alternate hollow and common herring-bone firebars, so that one half of the grate is worked with forced draught and the other with natural. The grate is 6½ ft. square, covered by a semi-circular firebrick arch, the crown of which is five feet above the bars, and the hopper drops the bagasse in the centre. Ratio of heating surface to grate area is about 118 to 1, but no combustion chamber is provided and consequently the gases are no sooner ignited than they are cooled again by the cold blanket of tubes: a low, irregular, initial temperature and much smoke is the result. For certain kinds of bagasse, such as has been found in some of the new varieties of cane, an intense draught is required to blow it into a flame, and this type of grate would be very suitable, but a combustion chamber is absolutely necessary to attain the best results. Ordinary megass from well grown tropical canes such as the Bourbon requires no more than two to three-tenths of an inch of water pressure in the ashpit, for which a chimney 130 ft. high is ample; but some soft, pithy canes are met with which require a much greater intensity of draught for the good combustion of their megass, and for such canes forced draught is a necessity. Each boiler here has an independent chimney 5 ft. bore by 105 ft. high, the bottom plates being three-sixteenths thick and the top No. 10 gauge, the height being scarcely sufficient for good natural draught, especially with such small grates.

Boiler Feed. The boilers are fed by two 14 in. and 9 in. by 18 in. Cameron direct acting steam pumps, which draw their water from a feed water receiver 5 ft. diameter by 30 ft. long, into which the condensation water from all parts of the factory gravitates or is pumped when necessary. The feed pump works steadily all the time, and any surplus that the boilers may not take overflows from a feed water regulator through a relief valve, this regulator being a tank 4 ft. diameter by 9 ft. 6 in. high placed in the main feed pipe close to the pumps. Any surplus water from the feed water receiver overflows to a tank and is pumped into large storage vats. The forced draught plant consists of two 6 in. by 10 in. horizontal engines, each belted through a countershaft to a No. 12 Buffalo Blower, and the air is led to the furnaces by a galvanized iron main pipe running the length of the boilers and situated behind and below the fire grates, with a branch pipe to each.

Juice. The juice from the crushers falls into the first mill beds and gravitates with the first mill juice to the liming tanks, passing over mechanical strainers, which are brass perforated canals, continually scraped by a slowly moving endless chain fitted with paddles which remove and elevate the cush-cush and return it in the intermediate carrier. The second mill juice flows by itself through similar canals to separate liming tanks.

Liming Station. The liming station has two mixing tanks, 4 ft. 6 in. diameter by 4 ft. deep, fitted with stirring gear driven by a Pelton wheel, which also drives a 6 in. by 6 in. single acting vertical pump which circulates the milk-of-lime through piping up to the defecators on the top floor and back by the liming tanks on the ground floor so that the juice may be limed at either or both places. From these liming tanks the juice gravitates to the juice pump suction tanks, from which it is pumped through horizontal tubular juice heaters to the defecators. The juice pumps are Cameron direct acting, that for first juice, 8 in. and 9 in. by 13 in., and for second juice, 6 in. and 6 in. by 7 in.

Juice Heaters. These are rectangular steel boxes, each containing 120 $1\frac{3}{4}$ in. brass tubes, 10 ft. $10\frac{1}{2}$ in. long, expanded into a tube plate at one end, and fitted with rubber gaskets, and glands at the other; heating surface 591 sq. ft. Three heaters are provided for first juice and one for second. The tubes are arranged in ten horizontal rows of 12 tubes, to ensure a high velocity, and they are worked with back pressure steam, safety valves being fitted to blow off at 10 lbs. pressure.

Defecators. Through the heaters the juice is pumped up to the defecators on the top floor, on which are also the three vacuum pans, quadruple evaporator, and syrup boxes. There are 18 defecators of 1500 gallons capacity, circular shaped, fitted with steam coils of 75 sq. ft. heating surface. Fourteen are used for first mill juice, and four for second mill juice. They are made of $\frac{3}{16}$ in. steel plate in the curb, and $\frac{1}{4}$ in. plate bottoms, and the mountings consist of 5 in. juice inlet cocks, 3 in. lime water cocks, 2 in. fresh water cocks, 1 in. bore internal perforated ring for washing down, three 3 in. run-off cocks for decanting at different levels, and 3 in. plug in bottom for discharging sludge.

The defecated juice gravitates to tanks set on columns on the floor below, these tanks being sufficiently high to allow the juice to gravitate through the mechanical filters on the same floor. Two tanks of 2400 gallons are for first juice, and two of 650 gallons for second juice. There are two tanks of 2400 gallons beside them for "cachaza," or sludge, and the bottoms of the defecators gravitate to them.

Mechanical Filters. There are 18 of these, six being intended for first mill juice, six for first syrup, four for second mill juice, and two for second syrup, but the syrup filters are not used. These filters are of the Scheibler type, each with 485 sq. ft. of cloth, in 45 sections, with $\frac{3}{4}$ in. outlets. The inlets are 4 in. bore, and on the bottom of each is a $2\frac{1}{2}$ in. cock for discharging the sludge to a 650 gallon tank on the ground floor, from which a 4 in. and 4 in. by 7 in. Cameron pump elevates it to the "cachaza" tank on the second floor. These filters work very well, and six of them are found ample to pass the

juice of 75 tons of cane per hour. The filtered juice gravitates to two 2400 gallon tanks on the ground floor, from which it is pumped up into two quadruple charging tanks on the top floor, a 6 in. and 6 in. by 7 in. Cameron pump being used for the first juice and a 4 in. and 4 in. by 7 in. for the second. Here the first mill juice and the second mill juice are mixed, no attempt having been made so far to keep them separate, although provision is made for working the second mill juice separately in the first vessel of the quadruple.

Filter Presses. The "cachaza" is forced through the filter presses by a special horizontal Guild and Garrison 8 in. + 5 in. by 10 in. pump at a pressure of about 50 lbs. per square inch at pump. There are 12 presses of 40 chambers, and 500 sq. ft. cloth, and the filtrate gravitates to the filtered juice tanks on the ground floor.

Lillie Quadruple Effet. This is rated at 400,000 gallons juice concentrated 75 per cent. in 24 hours. Each vessel has 432 3 in. copper tubes, 2580 sq. ft. heating surface, or a total of 10,320 square feet. The vapour pipes between the vessels are 36 in. diameter, and the pipe to the condenser is 42 in. diameter. The condensers of the pans and Lillie are of the Torricellian type, and the outlets are all connected to a manifold, with which are connected three Guild and Garrison dry vacuum pumps, fly-wheel type, 14 in. + 22 in. by 9 in. The centrifugal pumps for circulating the juice over the heating surface in the Lillie, and the pump for the condensation water, are driven by a direct connected Westinghouse engine, 12 in. by 11 in., running 300 revolutions per minute. The greatest care must be taken to keep the joints on back covers absolutely tight, and to see that the distributing tubes in the vessels have the proper amount of pitch upwards to give an approximately even distribution of the juice over the heating surface, as neglect of either or both of these points is sure to result in loss by priming. The Westinghouse engine, as usually made, has a Babbitt metal bearing in upper end of connecting rod, which is a mistake, as it is liable to get overheated, when the metal wipes round and closes the oil holes entirely, and it is a matter of a few hours at most till the end of the rod is worn entirely through and the engine stops for repair, and as the engine is single acting the pressure is always on top, and so there is no warning knock. The syrup from Lillie runs into a 650 gallon tank in the floor, and is pumped by a 5 in. + 5 in. by 7 in. Cameron pump to the syrup boxes on the same floor, situated behind the pans.

There are 18 syrup boxes, in a double row, all 2400 gallons capacity, piped to the pans, and six of them are fitted with 2 in. bore perforated steam pipes for steaming molasses. The syrup pipes to the pans are 6 in. bore.

Vacuum Pans. There are three pans, 12 ft. diameter, 8750 gallons capacity to striking level, fitted with one double and five triple coils, making 17 inlets and outlets; the coils are 4 in. in diameter;

heating surface 1000 sq. ft. The bottom sections are 4 ft. 9 in. deep, then two belts 4 ft. 6 in. deep, and dome 6 ft. 6 in. deep, vapour pipe 50 in. diameter, separator 74 in. diameter by 96 in. deep, condensers 5 ft. diameter, discharge valve 30 in. diameter, worked on a hinge with worm gear, 12 in. diameter sluice valve for molasses sugar discharge, 6 in. syrup pipe, 4 in. water pipe, and 3 in. steaming-out pipe. All the pans are connected by a 6 in. syrup pipe on the bottom. One pan is connected directly with the crystallizers, and the other two with a chute down into the mixer of the first sugar centrifugals on the ground floor. The water for the condensers is taken from the sea, being pumped up into a tank 20 ft. diameter by 15 ft. deep, standing on top of an iron tower 65 ft. high in the yard. There are two salt-water pumps, 22 in. + 21 in. by 24 in., of the Hall direct acting type, 18 in. suction, 16 in. discharge, and the water gravitates from the tank to the condensers. Such an immense tower is hardly necessary, as the condensers might easily lift their water 15 ft.

Crystallizers. There are 10 crystallizers, 8 ft. 10 in. internal diameter by 19 ft. 10 in. long, 9,000 gallons capacity, with jackets for hot or cold water and internal stirrers revolving at the rate of half a revolution per minute, driven by worm gear, each independently from a countershaft driven by an electric motor which also drives the sugar elevators and scroll conveyor below the crystallizers for conveying the second sugar masse-cuite to the centrifugals as well as the washing machine and hydro-extractor for the filter cloths.

Centrifugals. These are on the ground floor, arranged in one line, 10 for first sugar and five for second, of the water driven type. The baskets are 40 in. diameter, each driven by a 23 in. diameter Pelton wheel, supplied with water at a pressure of 180 lbs. per sq. in. by a 22 in. + 12 in. by 24 in. Guild and Garrison direct acting duplex pump. The mixers and sugar conveyors are driven by separate water motors, and the mixers are connected by a 14 in. pipe and isolating sluice valves. There is an elevator to each set of machines lifting the sugar to a bunk, where it falls on a rapidly revolving wooden fan which scatters, cools, and mixes it, and 12 spouts are provided below for drawing it off into bags. After the bags are weighed and sewn they are piled up in the warehouse by means of a two-ton electric travelling crane, which also lifts them convenient for loading the railway cars, which run into a lean-to shed alongside and they are then run down to the wharf alongside the steamers. Only 96 test sugar is made, the first molasses being reboiled in a portion of the first masse cuite and struck into the crystallizers, the balance of the first masse-cuite being cured hot. The molasses from the crystallized sugar is pumped through a 6 in. bore pipe to a tank on the wharf; this tank is 50 ft. diameter by 30 ft. high, holding about 428,000 gallons, and from this tank it can either be filled off into puncheons or run direct on board a tank steamer, and a large manhole is

provided near the bottom for recovering the sugar which crystallizes out and settles to the bottom. This finishes the description of the sugar factory proper, but a short description of the electric plant, machine shops, &c., in connection, may be interesting.

Power Plant. The principal object of this plant is to supply power for irrigation pumps for the 2000 or more acres under cultivation by the company, besides the lighting of the factory, wharf, and houses, as well as a few motors for various purposes about the buildings. The boiler plant consists of three 200 h.p. Stirling boilers, with grates for burning soft coal and the usual mountings, each having 2012 sq. ft. heating surface and $45\frac{1}{2}$ sq. ft. grate area. Steam is delivered through a 10 in. main to two tandem compound condensing engines 13 in. + 26 in. by 36 in., 320 h.p. at $\frac{1}{4}$ cut off and 390 h.p. at $\frac{1}{3}$ cut off, of the Fitchburg Engine Co.'s make. These engines are equipped with self-oiling devices, steam jacketed receivers, and have a guaranteed efficiency of 15 lbs. steam per i.h.p. per hour with 26 in. vacuum. They are simple in design, have shaft governors, and are built specially for alternating current operation. The exhaust steam is delivered through a 12 in. main to a Wheeler Admiralty Surface Condenser, designed for a maximum temperature of 90° F. cooling water. The exhaust being condensed is pumped through a feed water heater and purifier, and then through a Green economiser back to the boilers. In addition to the two large engines there is a small simple engine of the same type 13 in. by 26 in., running 125 revolutions per minute, designed to operate at 100 lbs. pressure, condensing or non-condensing. The steam for this engine may be taken direct from the boilers or from the main, and the exhaust is connected to the main, which of course has a bye-pass to the air. The boilers carry 150 lbs. steam, but the small engine and the feed pumps operate at 100 lbs., a reducing valve being used for this purpose. The steam pipes are covered with asbestos sponge covering. The economizer, made by the Green Fuel Economizer Co., has 2034 sq. ft. heating surface, and is encased in an asbestos lined steel casing; a bye-pass leads direct to the chimney, which is steel, 5 ft. bore by 150 ft. high.

The two large engines drive by belt two 250 k.w. generators, General Electric Co.'s inverted type, revolving field. These generators deliver current at 6600 volts pressure, 3-phase, to the switchboard; from the switchboard it is distributed, first to the pumping station line, second to rotary convertors, through transformers, and third to lighting, through transformer. The current for the pumping stations comes from the generator panel of the switchboard to the high tension panel, where it is measured and recorded, and thence to the different pumping stations on three bare No. 4 copper wires, supported every 130 ft. on 30 ft. poles with high tension insulators. Lightning arrestors are provided at each pumping station, where also the current is transformed from 6600 volts to 220 and led to a switchboard and

thence to 3-phase induction motor geared to a Root rotary pump. These motors are 75 h.p., and run at 500 revolutions per minute, and the pumps have a capacity of 4,000,000 gallons per 24 hours with 70 ft. head. Besides four pumps of this capacity there is one of 2,800,000 gallons which supplies water for the factory and houses operating under a head of 120 ft. All the water is obtained from driven wells, 2½ in. bore pipes, at depths varying from 40 to 60 ft., about 60 wells to each pump. Power for the various motors in the factory, such as electric cranes for handling the cane, crane in sugar warehouse, motor for crystallizers and motors in machine shops is obtained from rotary converters, which are designed to convert the alternating current into direct current at 125 volts, these rotaries receiving the alternating current from the main generator through the switchboard and transformers. When the main plant is shut down, one of these rotary converters is run from small engine through a friction clutch and countershaft and delivers direct current for factory use or for lighting. During the day all lighting and power required in the factory is supplied by one of the rotary converters, but at night one of the lighting transformers is used for the lights on the wharf, in the yard, office, and houses, leaving the rotary converters free for the motors and lighting in factory, the alternating current for lighting being reduced to 125 volts through the transformer.

The power house is a steel building covered with galvanized sheets 130 ft. long by 75 ft. wide, the engine room floor being 5 ft. 6 in. above ground, leaving ample space for running wires, piping, &c., underneath. The whole is spanned by a hand power travelling crane.

In the carpenter's shop there are circular, rip, and cross cut saws, planing machine, band saw, and a morticing machine all driven by a 10 h.p. electric motor; while in the engineer's shop there are one large and one small lathe, a shaper, two pipe threading machines, a bolt threading machine, and two emery wheels all driven by a 15 h.p. motor or by a steam engine with vertical boiler, which also works a small ammonia ice plant turning out 1000 lbs. ice per day.

In the field there is a Fowler's steam ploughing outfit, capable of ploughing eight to ten acres per day, a portable 40 h.p. boiler with Worthington pump for irrigation, pumping about 100 gallons water per minute. There is also a stone quarry with steam stone crusher and portable boiler, the plant being capable of crushing about 60 tons of limestone per day. This plant was indispensable for crushing stone for concrete foundations and also for ballast for the railroad. A continuous working limekiln, turning out about six puncheons of temper lime per day, has been built at the quarry. This completes the description of what should prove one of the finest sugar plants in the world, capable of turning out about 180 tons of sugar per 24 hours. The first crop completed in May this year yielded about

10,000 tons of sugar, about half being grown by the factory and half by *colonas*. Owing to extraordinary drought, consequent to the eruptions in Martinique and St. Vincent last year, this crop has turned out about 40 per cent. short all over the island, and the drought was more severely felt at Guanica owing to an insufficiency of water for irrigation. The south and west portions of Porto Rico always suffer from drought and irrigation is a necessity; but there is plenty of land available in the eastern part of the island for planting cane where artificial irrigation is not necessary, and only the necessary capital and enterprise to erect factories are required. With land yielding about 40 tons of cane per acre, and an unlimited native labour supply, with free market in U.S.A., any well managed sugar factory ought to pay handsomely.

LEVAN: A NEW BACTERIAL GUM FROM SUGAR.*

By R. Greig-Smith, M.Sc., and Thos. Steel, F.L.S., F.C.S.

(Continued from page 510.)

We will now offer a few comments on the means to be used to prevent the undesirable growth of *Bac. levaniformans* in the syrups and liquors of the factory or refinery as well as amongst the bulk sugars. The bacillus itself is readily destroyed by a very moderate amount of heating, such as is commonly used during the ordinary processes of defecation and boiling. But not so the spores, which, as we have shown, can resist exposure to boiling water for at least five hours, and so can pass unscathed through all the heating operations to which they would be subjected during the process of manufacturing or refining sugar. In the case of those raw sugar mills which make use of superheating methods of clarification, during which operation the cane juice is subjected under pressure to a temperature higher than the boiling point of water, it may be that the spores are destroyed. But as the operation usually lasts for a very short time, we are doubtful if complete destruction of the spores will result. Obviously our aim should be to so check the growth of the organism as to prevent any formation of spores inside the walls of the factory. In dealing with the various syrups and liquors this can readily be done by taking care that these do not lie for any longer time than can be avoided, but are kept hot and worked up as rapidly as possible. In the refinery special attention should be given to the thin runnings and sweet-waters, from filters, char-cisterns, &c., as these are particularly liable to bacterial growth of many kinds, whilst in the sugar mill the cane juice itself forms a perfect pabulum for the same class of organisms. Further, every care should be taken, by frequent washing, to keep all tanks and vessels scrupulously sweet and clean. But more than this will be

* From Journ. Soc. Chem. Industry.

necessary. Not only must the vessels themselves be kept clean, but the floors and surroundings also. Any pools or dark corners in which spillings and splashes of saccharine liquids can lie and ferment will quickly become points of infection from which crops of spores, not only of the organism which we have been considering, but also others perhaps equally harmful, may contaminate everything in the factory. By preventing the growth of the bacillus during the process of manufacture or of refining, we shall have gone a long way towards having the finished sugar free from this objectionable organism. If the bacillus be not present in the liquors from which the sugar is boiled, it can only get into the latter extraneously, and if care be taken to keep the entire factory clean and free from sources of infection, obviously the chance of contamination of the sugar is very much reduced.

In bulk raw sugars it is a curious fact that it is not in those of low quality such as are known as second jet, syrup tank, or concrete sugars, that the greatest amount of depreciation through the growth of the bacillus has been found. Although such sugars always hold much more moisture and organic matters other than sugar, than do the first jet or first grade sugars, and would therefore naturally be considered as so much more suitable for the support of the bacillus, the greatest amount of depreciation has been actually found to take place amongst the better grade sugars. In fact so small is the change usually taking place in low quality sugars during storage, that it is comparatively unimportant and is hardly worth consideration. The cause of this is not easy to find, but in all probability it lies in some difference in the nature of the associated organic bodies in the two classes of sugar, though the chemistry of the subject is at present not sufficiently well advanced to enable us to arrive at any definite conclusion on this point.

Without doubt the best plan for the prevention of the injurious growth of the bacillus in the high-grade sugars is to render these physically unsuitable for the well-being of the organism. The most obvious means of attaining this end is to render the sugar as dry as possible, whilst at the same time the purer they are made the simpler becomes the problem of making them sufficiently dry, and the less nutrition, in the form of nitrogenous organic bodies, is left for the nourishment of the bacillus. The most efficient method known to us for attaining this double end is to submit the sugar, whilst in the centrifugal machine, to the cleansing action of steam. Highly efficient appliances for this purpose, such as Walker and Patterson's patent machine, are readily obtainable, and the hot purified sugar, when it leaves the machine, easily attains a degree of dryness which renders it quite proof against bacterial growth. If steaming of the sugar is not practicable, drying, though in a much less perfect degree, can be carried out in one of the well-known appliances used for this purpose.

In most tropical climates the sugar, after such treatment, will readily absorb sufficient moisture from the atmosphere to permit of mischievous bacterial growth taking place. Care should therefore be taken to so stack the sugar after bagging, as to reduce to a minimum the surface exposed to the air, and to have it shipped to its destination as quickly as can be managed. No advance in this matter can be made without trouble, and the losses to manufacturers through bacterial depreciation have in the past been so enormous as to render it imperative that every possible means be used for its prevention.

DISCUSSION.

Dr. Frew said that the development of viscosity by the agency of micro-organisms was of interests to brewers, wine growers, dairy proprietors, and even to those engaged in the manufacture of gum, as well as to the sugar refiner. He (Dr. Frew) was most interested in the author's account of the chemical action of the *Bac. Levaniformans* upon cane sugar solutions, and in the way in which they had been able to separate the invertive and fermentative (gum-forming) functions of the organisms. Having regard to the fact that the levulose formed by the inversion of the cane sugar diminished in quantity as the gum increased, and that, by the hydrolysis of levan, levulose was produced, it was evident that the gum-formation was the result of a fermentative change of this sugar. He (Dr. Frew) inclined to the belief that the formation of levan was a true fermentative change in the fluid, and not simply the development by the organism of a diffluent sheath or capsule. The non-production of levan by the organism when grown in levulose solutions might be simply due to want of the proper conditions, as, for instance, the absence of dextrose and it would be interesting to ascertain what would occur if the organism were grown in a nutrient solution containing dextrose and levulose in equal quantities.

Mr. Biggart thought the Society very much indebted to our Colonial members for their instructive and valuable paper. Whilst not prepared to criticise the paper from a bacteriological point of view, he could speak from experience regarding the serious deterioration sugar occasionally suffered on keeping, and what a benefit and source of profit to the trade would be any discovery which would remove or arrest this harmful alteration.

He recalled particularly, the case of a West India sugar of which he made a test. The refiners original sample gave about $1\frac{1}{2}$ per cent. of invert sugar, and on melting the sugar some months thereafter, it was found to work very badly, and a fresh test showed that invert sugar had risen to between 7 and 8 per cent. This change at once explained the unsatisfactory refinery results. He also referred to the greatly accelerated depreciation of raw beet-sugar when it becomes acid, stating that new beet-sugars are either all alkaline or tend to be so.

The authors, in their paper, referred to the peculiar circumstance

that many low sugars, which one would consider must contain more bacterial food, and so would be subject to greater change, keep well, and often very much better than the drier sugars. He suggested as an explanation (the bacteria being aërobic) that it was most probable that, within low syrupy sugars, little or no circulation of air was going on, and so the bacteria would find these low sugars unsuitable habitats.

Mr. Steel, in reply, said that Dr. Frew had raised some interesting points which, like many other side-issues that arose during the progress of the investigation, were most enticing. But to get to any sort of finality, it had been found necessary to carry out the main line of the research, leaving many matters for future study.

The question of the precise nature of the gum, whether it was formed as a direct product of the fermentation, or consisted merely of the diffluent capsule of the organism, was one which was not easy of solution; but they were disposed to the latter hypothesis, which was the conclusion also arrived at by Marshall-Ward and Reynolds Green in their study of a similar organism.

Mr. Biggart's experience with a sugar suffering heavy inversion was an interesting one, but one which was all too common in the trade. He (Mr. Steel) had no doubt that the mischief was due to the bacillus under consideration.

Possibly, the immunity of moist low-grade sugars might, to some degree, be due to the cause mentioned by Mr. Biggart, but he thought that there was more than this. In his (Mr. Steel's) experience, samples like the case instanced in the paper, which were so wet as to form a dense syrup, would allow of a full growth of the organism.

Comparitively speaking, very little air was required for the growth of the bacillus, and air would diffuse slowly through even very sticky sugars. Doubtless careful investigation would clear up points like this, which at present it is impossible to explain.

PUBLICATIONS RECEIVED.

Karte de Zuckerfabriken Spaniens (Map of the Spanish Sugar Factories.) Verlag von Schallehn & Wollbrück, Magdeburg. Price, 5 marks.

Apart from a folded map, this publication has a list of 48 beet sugar factories and 30 refineries in Spain. The map itself is very well executed and singularly accurate for a work of this class; and all those firms desirous of pushing their sugar machinery in Spain will do well to get a copy.

Zabel's Jahr-und Adressbuch der Zuckerfabriken Europa's, for the Campaign, 1903–04. 34th year of issue. Published by the Centralblatt für die Zuckerindustrie, Magdeburg. Price, 4 marks.

MONTHLY LIST OF PATENTS.

Communicated by Mr. W. P. Thompson, C.E., F.C.S., M.I.M.E. Chartered Patent Agent, 6. Lord Street, Liverpool ; and 322, High Holborn, London.

ENGLISH.—APPLICATIONS.

23692. R. Fölsche and F. Nowak, Berlin. *Improvements in column-shaped crystallisation vessels for sugar filling masses.* (Complete specification, 2nd November, 1903.)

ABRIDGMENT.

19962. F. Meyer, London, E.C. (Communicated by J. W. Meyer, Carapichaima, Trinidad, and J. W. Arbuckle, Coura, Trinidad.) *An improved means of evaporation for the concentration or condensation of saccharine syrups, brine, or other fluids.* 16th September, 1903. These improvements relate to the apparatus used for the purpose of evaporation, for concentration or condensation of saccharine syrups, brine, or other fluids, and consist of a sparger or sprinkler fitted inside each vessel, and also of a pump fixed at the lowest point or suitable position of the said vessels, whereby the syrup or other fluid is distributed evenly over the bare hot tubes in the bottom of the vessels and if found necessary the syrup or other fluid can be forced back through the sparger or sprinkler and redistributed over the bare hot tubes in the same vessel for further concentration or condensation.

GERMAN—ABRIDGMENT.

141589. The Cereal Sugar Co., St. Louis, Mass., U.S.A. *A process and apparatus for making compressed sugar starch containing at least 98 per cent. of glucose hydrate.* 25th June, 1901. This invention relates to a process for purifying raw glucose and apparatus serving for carrying out the said process. Hard, crystalline, non-pasty, raw sugar starch, which is brought into block form by compressing small pieces, or by casting, is compressed under gradually increasing and very high pressure (175 to 420 kilogrammes and even beyond that per square centimetre) in such a way that the product contains at least 98 per cent. of glucose hydrate ($C_6H_{12}O_6$ H_2O). An apparatus is used for carrying out the process consisting of plates open at the ends, which are drawn into a press and are closed at the sides by ribs, and bevelled bars. These engage and clamp, together with the bars of the next plate, the over-hung edges of the casing surrounding the cake of sugar so firmly that any projection of the sugar is prevented.

142195. J. J. E. Bekker, Amsterdam. *A mill for crushing sugar cane by which the rollers form a triangle.* April 6th, 1902. The rollers in this crushing mill are so arranged that the preliminary

pressing roller lies at an angle of 65° laterally from the covering and high pressure rollers which are placed vertically one above the other. The rollers are provided with rectangular and triangular flutings, the flutings of the front and high pressure rollers and those of the covering roller engaging with one another, whilst a bridge piece is arranged between the front and high pressure roller, which engages in the flutings and is provided with support rollers running in the flutings.

142763. HEINRICH PASSBURG, Moscow. *Apparatus for rapidly casing and drying sugar in moulds.* July 2nd, 1902. The filled moulds are firmly connected with a pipe leading to an air pump, and may be turned with this pipe in such a way that the casing liquid may be drawn into the sugar mass from beneath upwards and in the reversed position of the moulds drawn out again. The casing liquid is contained in vessels arranged beneath the sugar moulds in such a way as to be adjustable in height in order to enable the quantity of casing liquid drawn in to be suitably regulated.

142823. EMIL PASSBURG, Berlin. *A process for drying sugar loaves.* 31st July, 1903. The drying under vacuum which was described in patent No. 142191 is only continued until half or more of the original moisture contained in the loaves has been extracted. The ordinary drying process without vacuum is then utilised for extracting the remainder of the moisture.

144192. AUGUST GRANTZDORFFER, Magdeburg. *A pipe for introducing syrup into vacuum pans and crystallising vessels.* November 2nd, 1901. The invention is based on the observation that in order to produce a good crystallisation of sugar whether in vacuum pans, or any special crystallising vessels, the fresh entering juice must preferably have the same temperature as that already contained in the vacuum pans or crystallising vessels, and also that the entering juice must have as wide a surface of contact as possible with the juice already in the vessel. In order to fulfil these conditions an arrangement is adopted consisting of a group of vertical downwardly open pipes, or one such pipe, being arranged in the interior of the vacuum pan or vessel, the total periphery of which pipe or pipes is larger than that of the feed pipe. By this arrangement the juice entering through the feed pipe or pipes, assumes the same or approximately the same temperature as the juice in the vessel has, as either the contents of the vessel serves as means for heating the contents of the pipe, or vice versa the contents of the pipe for heating the contents of the vessel. The enlargement of the periphery of all the pipe mouths produces a discharge of the escaping juice in layers of very large surface, thus producing an extensive contact with the contents of the vessel. This action is further increased by the distributing pipes having pyramidal, conical or like enlargements at

their lower ends with a horizontal under surface, in this way their periphery affords a much longer drip edge than the mouth of the pipe itself. The particles of juice emerging from the lower opening cannot rise into the mouth of the pipe under the action of the vacuum existing in the vessel, but must extend over the horizontal surfaces of the cap or hood and then rise upwards in a state of fine distribution to a certain extent as a thin wall. In this arrangement the crystals assume a flat flaky form corresponding to the above mentioned method in which the juice rises, which is again favourable for subsequent washing on account of the large superficial area.

14574. MORIZ WEINRICH, Yonkers, New York. *A method of purifying raw sugar by means of lime and preventing inversion.* September 30th, 1902. This invention relates to a method of treating raw sugar to be carried out before the latter is subjected to the ordinary refining process. The treatment allows of a much more thorough purification than has hitherto been the case and also when employed for beet sugar removes the disagreeable taste and smell of the final molasses and syrup. Raw sugar which is treated by this process can also be kept for a long time without the crystallised or uncrystallisable sugar contained therein undergoing any change. The process consists in mixing with the raw sugar a small quantity (2 to 5% of the weight) of finely ground, burnt and slaked, pulverulent lime, and heating and aerating the mixture. The mixing may be done either in a suitable mixing apparatus, or a given quantity of raw sugar is spread in a thin layer and a suitable quantity of lime powder uniformly distributed thereon by means of a fine sieve and then the whole thoroughly mixed by means of shovels. After this treatment the non-sugar is either washed out of the sugar crystals and the lime saccharate adhering thereto, or the raw sugar treated as above described with lime, is dissolved and the lime separated out of the solution by means of precipitation and filtration.

Copies of all published specifications with their drawings in these lists can be obtained from W. P. Thompson & Co., 6, Lord Street, Liverpool, at One Shilling a copy for English or American Patents, and Two Shillings for German. In ordering please give number and date.

IMPORTS AND EXPORTS OF SUGAR (UNITED KINGDOM,)

To end of October, 1902 and 1903.

IMPORTS.

Raw Sugars.	Quantities.		Values.	
	1902.	1903.	1902.	1903.
	Cwts.	Cwts.	£	£
Germany	5,495,138	4,369,534	1,898,302	1,836,825
Holland	286,586	184,109	91,195	71,152
Belgium	523,471	658,501	186,078	272,903
France	1,688,258	524,246	651,276	229,534
Austria-Hungary	84,770	1,542,961	28,198	646,458
Java	....	359,537	....	174,602
Philippine Islands	....	70,646	....	25,285
Peru	109,335	301,891	37,822	124,895
Brazil	548,894	67,639	180,637	26,394
Argentine Republic	592,466	418,369	218,152	184,709
Mauritius	323,696	264,311	111,316	94,346
British East Indies	167,816	264,420	61,376	97,127
Br. W. Indies, Guiana, &c.	1,183,974	565,883	692,353	340,280
Other Countries	142,285	898,485	54,699	412,968
Total Raw Sugars	11,146,689	10,490,532	4,211,404	4,537,478
Refined Sugars.				
Germany	11,338,987	12,640,647	5,889,217	6,618,979
Holland	2,046,953	1,823,311	1,171,873	1,065,727
Belgium	135,774	113,379	78,313	66,524
France	2,142,367	758,556	1,119,653	429,252
Other Countries	11,348	861,794	5,587	426,662
Total Refined Sugars	15,675,429	16,197,690	8,264,643	8,607,144
Molasses	1,141,692	1,284,427	218,840	235,520
Total Imports	27,963,810	27,972,649	12,694,887	13,380,142

EXPORTS.

British Refined Sugars.	Cwts.	Cwts.	£	£
Sweden and Norway	36,991	30,107	20,202	15,047
Denmark	113,890	82,363	57,857	44,867
Holland	58,230	56,853	30,369	30,689
Belgium	8,029	9,986	4,031	5,072
Portugal, Azores, &c.	7,069	8,176	3,525	4,647
Italy	21,064	7,472	9,935	3,442
Other Countries	356,340	653,713	209,844	400,714
	601,613	848,670	335,763	504,478
Foreign & Colonial Sugars.				
Refined and Candy	40,815	35,772	25,829	22,258
Unrefined	76,832	52,932	38,242	27,957
Molasses	2,519	1,867	988	892
Total Exports	721,779	939,241	400,822	555,585

UNITED STATES.

(Willett & Gray, &c.)

(Tons of 2,240 lbs.)	1903. Tons.	1902. Tons.
Total Receipts, 1st Jan. to Nov. 12th ..	1,473,865	1,616,586
Receipts of Refined ,, ,, ,, ..	1,264	18,081
Deliveries ,, ,, ,, ..	1,439,005	1,621,965
Consumption (4 Ports, Exports deducted) since 1st January	1,500,682	1,557,394
Importers' Stocks (4 Ports) Nov. 11th ..	37,245	19,932
Total Stocks, Nov. 25th	103,000	188,713
Stocks in Cuba ,, ...	122,000	74,958
	1902.	1901.
Total Consumption for twelve months ..	2,566,108	2,372,316

CUBA.

STATEMENT OF EXPORTS AND STOCKS OF SUGAR, 1902 AND 1903.

(Tons of 2,240lbs.)	1902. Tons.	1903. Tons.
Exports	691,657	826,108
Stocks	131,544	158,593
	823,201	984,701
Local Consumption (nine months)	31,750	30,720
	854,951	1,015,421
Stock on 1st January (old crop)	19,873	42,530
Receipts at Ports up to 30th September..	835,078	972,891

J. GUMA.—F. MEJER.

Havana, 30th September, 1903.

UNITED KINGDOM.

STATEMENT OF IMPORTS, EXPORTS, AND CONSUMPTION FOR TEN MONTHS ENDING OCTOBER 31ST.

SUGAR.	Imports. 1903. Tons.	Imports. 1902. Tons.	Imports. 1901. Tons.	Exports (Foreign). 1903. Tons.	Exports (Foreign). 1902. Tons.	Exports (Foreign). 1901. Tons.
Refined	809,884	783,771	819,032	1,789	2,041	3,327
Raw	524,527	557,334	527,706	2,647	3,842	5,279
Molasses	64,221	57,014	74,864	93	126	2,518
Total	1,398,632	1,398,189	1,421,602	4,529	6,009	11,124

HOME CONSUMPTION.

	1903. Tons.	1902. Tons.	1901 Tons.
Refined	757,276	782,718	—
Raw	402,358	531,337	—
Molasses	58,990	53,330	—
Total	1,218,624	1,367,385	—
Less Exports of British Refined	42,433	30,081	—
Net Home Consumption of Sugar	1,176,191	1,337,304	1,374,495*

* Trade estimate.

Stocks of Sugar in Europe at uneven dates, Nov. 1st to 25th, compared with previous Years.

In thousands of tons, to the nearest thousand.

Great Britain.	Germany including Hamburg.	France.	Austria.	Holland and Belgium.	Total 1903.
97	809	576	303	138	1925

	1902.		1901.		1900.		1899.
Totals	845	..	1549	..	1233	..	1196

Twelve Months' Consumption of Sugar in Europe for Three Years, ending October 31st, in thousands of tons.

(From Licht's Monthly Circular.)

Great Britain.	Germany	France.	Austria.	Holland, Belgium, &c.	Total 1902-03.	Total 1901-02.	Total. 1900-01.
1712	846	557	407	508	4030	4047	4179

Estimated Crop of Beetroot Sugar on the Continent of Europe for the current Campaign, compared with the actual crop of the three previous Campaigns.

(From Licht's Monthly Circular.)

	1903-1904. Tons.	1902-1903. Tons.	1901-1902. Tons.	1900-1901. Tons.
Germany	1,880,000 ..	1,748,556 ..	2,304,924 ..	1,984,186
Austria	1,200,000 ..	1,057,692 ..	1,302,038 ..	1,094,043
France	810,000 ..	833,210 ..	1,183,420 ..	1,170,332
Russia	1,200,000 ..	1,250,000 ..	1,098,983 ..	918,838
Belgium	225,000 ..	215,000 ..	334,960 ..	393,119
Holland	125,900 ..	102,411 ..	203,172 ..	178,081
Other Countries .	410,000 ..	350,000 ..	393,236 ..	367,919
	5,850,000	5,556,869	6,820,733	6,046,518